2011 Study of the Long Island Creek Watershed: Sandy Springs, Georgia

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In conjunction with the Dr. Dick Farmer and Patty Berkovitz of the Watershed Alliance of Sandy Springs

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INTRODUCTION

The most consistent factor to the degradation of stream health and the ecosystem is the ever-increasing rate of urbanization (Paul & Meyer, 2001). A key factor to the processes that lead to stream impairment is the amount of impervious surfaces found in urban centers. Impervious surfaces impede the natural process of rain water infiltration that would otherwise be absorbed in a forested area's soil. The results are polluted water entering catchments due to surface runoff. This type of pollution is categorized as non-point source pollution and is caused by rainwater washing contaminants from automobiles, fertilizers, and exposed soils into streams. The amount of impervious surfaces an area has can be used to determine how susceptible that area is to non-point pollution (Harper, 2001). Water pollution from non-point sources remains a general contributor to the impairment of water quality across the nation, especially for urban areas like Atlanta, Georgia which is considered one of the fastest growing metropolitan areas in the United States (EPA, 2008).

Various approaches have been implemented to control pollution at both federal and state levels. According to the United States Environmental Protection Agency (EPA), common practices include watershed and land use planning, development of best management practices (BMPs), regulation, and liability provisions as a means to subside and or prevent further contamination of the nation's waterways. Georgia's own BMP is called Adopt-A-Stream (AAS); its goals are to educate citizens of non-point pollution and water quality issues and provide them with the training and tools to collect data and evaluate the current state of Georgia's waterways. To maintain consistent quality of data collection in the field, Adopt-A-Stream provides certification in chemical and bacterial monitoring procedures. As of June 2005, Georgia Adopt-A-Stream has trained more than 14,000 volunteers with 106 active groups monitoring in Georgia. Adopt-A-Stream encourages individuals and communities to monitor and improve sections of streams, wetlands, lakes, or estuaries.

In 2001, a watershed analysis of Long Island Creek was conducted by Matthew Harper, a student at Kennesaw State University under the supervision of Dr. Mark Patterson. Located in Sandy Springs, Fulton County, GA. Long Island Creek is a relatively small catchment within the Upper Chattahoochee watershed. Harper's analysis combined fieldwork determining physical characteristics of the watershed and computer analysis using satellite imagery to determine land use within the watershed. Various types of land use were found within the boundaries of the catchment including a major highway, a commercial district, a mix of low and high-density residential areas, open-land and forested areas. Using Landsat 7 imagery from September 28, 2000, Harper was able to classify the image by grouping spectral values that represented similar land use types generating an approximation of 15.853% impervious surface. The majority of the impervious surfaces were located in the north most section of the watershed where a large commercial district and major highway are located. Using the Adopt-A-Stream parameters, structures that could contribute to the degradation of the creek's quality such as erosion, sedimentation, sewer pipes crossing the creek, and structures in close proximity to the creek were documented to assess the condition of the stream and the adjacent banks. Based on Harper's analysis of Long Island Creek watershed, the stream's health was ranked as "Impacted" if not mitigated.

The Adopt-A-Stream program emphasizes the importance of community involvement regarding the maintenance and monitoring of natural streams in Georgia. For summer 2011, Dr.

Mark Patterson and Dr. Nancy Hoalst Pullen organized a watershed analysis and assessment course for the Long Island Creek watershed. In conjunction with the Watershed Alliance of Sandy Springs (WASS), an organization which monitors land use change and its effects on water bodies located in the city, Long Island creek was revisited. An in-depth analysis was conducted at 12 sites along the stream. Teams conducted physical, chemical, and bacterial assessments of their sites as well as visual survey and community inventories. The groups were able to assess the health of the stream in a much broader scope than the analysis conducted in 2001. The results found emphasize the local pressures on the stream and riparian habitat for each section that was studied.

RESEARCH GOALS AND OBJECTIVES

The main goals of this study are 1) To conduct a rapid assessment of the ecological health of the Long Island Creek Watershed, 2) To update and add to existing baseline data from the original study conducted within the watershed 10 years ago. There are several objectives of this study to help meet these goals. These objectives relate to water quality testing, vegetation indexing, stream channel characteristics, inventory of stream fish species, and land use patterns within the watershed. Specifically, the objectives contributing to the areas of this study are:

1. To determine the water quality of Long Island Creek by testing for the following:
    a. Bacterial parameters (*E. coli* and Fecal Coliform)
    b. Chemical parameters (Nitrates, Phosphates and pH)
    c. Physical parameters (Temperature, Dissolved Oxygen, and Conductivity)
2. To compile a community index of the vegetation within and surrounding Long Island Creek
3. To determine land use patterns and change in those patterns within the watershed since 2001
4. To determine stream channel characteristics
5. To conduct a fish species inventory within the creek

BACKGROUND

The analysis of the Long Island Creek watershed relied a great deal on the training and guidance of different organizations, as well as the implementation of different scientific processes. Working for the Watershed Alliance of Sandy Springs, groups were tasked with doing a thorough analysis of the Long Island Creek Watershed. With training and familiarization with the watershed from the WASS, as well as training in chemical water testing from the Georgia Adopt-A-Stream Foundation as a means to determine the health of the watershed, groups were able to carry out their studies. While doing the survey of the watershed groups focused their study on the land use practices in the Sandy Springs area as well as the local landscape ecology.

Watershed Alliance of Sandy Springs

The Watershed Alliance of Sandy Springs was "organized to restore and maintain the ecological balance of the watersheds of Sandy Springs, through education and monitoring, and to foster the preservation, character and integrity of the watershed region" (WASS, nd). The organization was started in 2002 by Patty Berkovitz and other residents living on Long Island Creek and was initially called the Long Island Creek Watershed Protection Association. They group was a collection of citizens that were concerned with property loss due to erosion problems along the creek. They started with the idea that it would be perfect if voting districts were based on watershed divisions, and that people of individual watersheds needed a voice in local government to deal with issues that they were facing. The Fulton county government aided in the initial startup of the organization, providing maps, helping to organize meetings, and assisting in mailings to get information out to all of the residents in what is now the city of Sandy Springs.

The organization's vision statement is as follows: "The Watershed Alliance of Sandy Springs, Inc. strives to attain a healthy, bio-diverse, aesthetically pleasing watershed system in Sandy Springs. We envision this happening through a well-educated citizenry, a community and local government that prioritizes watershed issues, and a city-wide focus on responsible development and the use of best land-and water-management practices" (WASS).

The Watershed Alliance of Sandy Springs sets out to achieve their vision statement by setting a number of goals for their organization. The focus on projects that allow them to increase awareness of watershed issues, encourage best land management practices, promote responsible development and land use, advocate for their neighbors and local environment, interact with county, state, and federal entities to affect change, and monitor the health and safety of the stream by conducting periodic creek walks and water sampling and testing. Having grown over the past ten years the alliance looks after all six of the watersheds in the city of Sandy Springs including Nancy, Long Island, Heards, Marsh, Sullivan, and Crooked Creeks. (WASS). Each of the watersheds has a contact person above it to organize projects within them.

The WASS has chosen to place itself in a monitoring role for the watersheds in the city of Sandy Springs. Because of this distinction they do not solicit any funds from the city and rely wholly on volunteers for work and monetary contributions. The project that the organization envisions doing the most good for the city's water problems would be the implementation of a storm water utility. This would be the most responsible way of dealing with the problems at hand, though the cost of it and the placement of responsibility for the many problems have been issues when dealing with the city. The biggest tool of the organization as it pertains to policy making decisions and changing people's thinking on issues is just to be present when decisions are made and make the issues known. This includes being on as many boards as possible, and visiting sites where construction is taking place, a force to remind and refocus people to prevent further problems in the future.

The study of Long Island Creek was done at the request of the Watershed Alliance of Sandy Springs, and was done as a comprehensive follow-up study to one done ten years ago in the same area. Dr. Dick Farmer is the member of the WASS board that works mostly with volunteer groups and student organizations that want to become active in their efforts and was the liaison to the group. Groups worked with him and with Patty Berkovitz as well, to do a thorough assessment of the watershed. Groups were also able to work with the WASS on a

stream restoration project on the property of one of the residents living on Long Island Creek. This consisted of three separate projects along his property to stabilize the bank and prevent future erosion and land loss on his property, while also increasing the health of the stream.

Adopt-A-Stream

Organizations like the Watershed Alliance of Sandy Springs generally need help getting started with their efforts. When starting up they need to have information on their watershed and maps of the area as well. One organization that can be instrumental in this is the Adopt-A-Stream Foundation. Adopt-A-Stream programs are excellent community outreach tools that are useful for municipalities to involve people of all ages and abilities in water protection efforts. They are volunteer programs in which participants "adopt" a body of water to clean up, monitor, protect, and restore it. Through these activities the monitoring group becomes the active caretaker of that area in a particular watershed. Adopt-A-Stream programs are very diverse and municipalities can create them to cater to their particular needs and the abilities of the volunteers that are assisting them (EPA, 2008).

The implementation process of municipalities starting an Adopt-A-Stream begins with obtaining a watershed map and marking potential stream on it. This map would then be used to keep track of which stretches of stream are adopted by whom. After stream sites are identified the next step is to develop a monitoring and reporting plan to evaluate the conditions of the stream. From there it is necessary to create "how to" packets on necessary activities in the area and then distribute them to interested parties. Municipalities can receive numerous benefits by implementing an Adopt-A-Stream program. Participants help to improve the visual attractiveness of a watershed and make the habitat more suitable for wildlife, helping to save and restore natural resources. Also since it is on a volunteer basis often with measured results, the hands on activities, recognition, and exposure that it provides for schools, organizations, and the community leads to a great sense of accomplishment.

The Georgia Adopt-A-Stream Foundation is a part of the Non-point Source Program in the Watershed Protection Branch of the Georgia Environmental Protection Division. The program has four major goals: "(1) increase public awareness of the State's nonpoint source pollution and water quality issues, (2) provide citizens with the tools and training to evaluate and protect their local waterways, (3) encourage partnerships between citizens and their local government, and (4) collect quality baseline water quality data" (Harbert, Zarneke, Giroux, 2005). These goals are accomplished through the encouragement of individuals and communities to monitor and or improve sections of streams, wetlands, lakes, or estuaries. They provide comprehensive support for these people through the use of training, manuals, technical support online and at over fifty sites throughout the state. Georgia Adopt-A-Stream has teamed up with many government and non-government groups to provide access to technical information and assistance to groups wishing to get involved with or implement projects in their local areas. (EPA, 2008).

The project made use of the Georgia Adopt-A-Stream Foundation from the onset. All members of the class were trained in chemical water testing in order to carry out field research. This consisted of training in how to test the water for dissolved oxygen (DO), phosphates, nitrates, and pH, all indicators of the health of a particular body of water. Dissolved oxygen

refers to the amount of oxygen that is dissolved in the water and is important to life in the water, too little oxygen in the water leads to less aerobic life and an increase in anaerobic life. Nutrients such as nitrates and phosphates typically enter a water source through runoff from agricultural areas with fertilized fields, urban runoff, animal production operations, waste-water treatment plants or as a byproduct of septic systems. High levels can lead and excessive aquatic plant growth, sometimes resulting in fish kills. Finally, pH is tested because water that is too acidic or too alkaline is not favorable for most bacterial processes that support life. Unnaturally high or low levels of pH are most commonly attributed to industrial point source discharges (EPA, 2008).With training and certification in chemical testing, along with the professors being certified in bacterial testing, groups were able to perform the tests needed to complete the field research.

Land Use Planning

One of the most important focuses of these organizations as it pertains to water quality issues is the land use planning for a given area. The integration of ecological principals into land use planning is a vital part of the preservation of biodiversity and functional ecosystems. It is important for ecologists to step into a role that allows them to shape land use planning for the better. There are four major areas of action that ecologists need to focus on to fill this roll: “1) educating members of the staff, planning board, and governing body involved in land-use decisions; 2) serving on a planning commission or governing body; 3) commenting at public hearings; and 4) participating in citizen review panels for land-use laws and policies” (Broberg, 2003). These are all steps that the Watershed Alliance of Sandy Springs has taken to be actively involved in the future land use planning for their respective area. This process is done through grassroots campaigning, educating the public on the issues that are involved with improper land use planning, as well as taking issues directly to those with the power to make decisions on the matter.

The effect of land use planning if often studied it is rarely implemented. This is because water management agencies typically address existing problems rather than try to prevent them. Water quality is the physical, bacterial and chemical state of the water in an area being tested. The diversity of plants and animals depends on the status of these factors. Chemical testing is the most prevalent way to test water quality; however, bacterial impacts are often not fully represented. In a study by the EPA, using both bacterial and chemical testing methods actually doubled the amount of harmful indicators found in the water tested. Bacterial water quality is based on the assumption that a water body should be able to support a balanced ecosystem similar to that of the natural habitat in the area. Since 1990, when the EPA implemented bacterial water quality guidelines, various water bodies and aquatic species have been studied.

There is a considerable spatial relationship between land use practices and water quality in any given area. This is exemplified by a study done of the Little Miami River watershed in Ohio. The study showed that water downstream from areas of high human impact, dominated by urban land use, or areas of point source pollution had significantly lower water quality (Wang, 2001). The watershed is dominated by gravel substrate and is mainly cropland. There is a high diversity on the river, but fish deformities can be found and attributed to pollutants exceeding the river’s capacity. Pollutant indicators included; DO, pH, suspended solids, NH_3, TOC, and water hardness. Point source pollutants were found from waste-water treatment plants and privately

owned plants. Land use data was made using Thematic Mapper and classified into urban, agriculture, shrub, wooded, open water, non-forest wetlands, and barren. The river was divided into sites based on waste-water treatment plant (WWTP) discharges and each site was given a river number, 26 were delineated and ArcView was used to determine land use. Sites were grouped based on location to WWTP's and location to point sources and urban land. T-tests were used to test whether or not water quality decreased below WWTP's and whether quality was worse in high human impact areas. Fish indicator values showed a decrease downstream of WWTP's, but macroinvertebrates and qualitative habitat evaluation index (QHEI) showed no significant difference. Both fish and invertebrates had lower values in high impact areas. Urban land use on the river ranged from 1-58 %, and agriculture use ranged from 12-95 % (Wang, 2001).

The data collected demonstrates that one of the biggest problems with water quality is change in land use patterns as a result of an increase in the intensity of human activities. In order for this problem to be dealt with, it is first necessary to establish the hydrological relationship between land-use and their surrounding water systems. Once this relationship is established, it is then necessary to protect the water quality with proper land-use planning and creating cost-effective pollution prevention and pollution correction methods. Working beside the Watershed Alliance of Sandy Springs allows us to have an impact on the land use planning for the city of Sandy Springs. As mentioned earlier, the organization is a voice in the community for protection of the watershed and is very outspoken on the topic of land use planning, both with infrastructure currently in place and with future building projects. The data groups collected will demonstrate the effects of poor land use management and will hopefully provide a platform to aid the WASS in their efforts.

LAND USE MAPPING

An efficient way to show a broad overview of land use in a given area is through the process of land use mapping. Like all fields of science, ecology is ever changing with the advent of new technology. One of the most significant technological advances affecting the study of ecology has been the use of satellite imagery. The widespread availability of remotely sensed images has made it easy for ecologists to characterize vegetation or land cover effectively with a bird's eye view. While this technology can be a great tool for ecological studies, it has also led to problems due to lack of understanding and misuse of the software programs developed for this use.

The first thing to consider when approaching a project is whether or not remote sensing is the right tool for the study at hand (Fassnacht, Cohen, Spies, 2005). Remote sensing is useful when there is a need for complete spatial coverage over large areas, monitoring of an area, and measurements at inaccessible locations. Remote sensing can be used to derive four types of data from an environment: landscape composition, landscape pattern, biophysical parameters, and changes over time of these three elements (Fassnacht et al., 2005).

An important aspect to using remote sensing is the development of information classes. Using hierarchical classification schemes allows for a balance between utility and accuracy. This is done by allowing users to define and organize detail that they desire, while allowing classes to

be collapsed if necessary if accuracies are unacceptable (Fassnacht et al., 2005). One of the most important things to consider when reviewing remotely sensed data is scale. The definition of scale as defined for this purpose is “the combination of extent, grain, and minimum mapping unit.” Changing any of these elements will change the scale of the mapped area (Fassnacht et al., 2005).

It is important to consider the fitness for use of any remotely sensed data being applied to other spatial models. There will always be an immeasurable amount of error and it is necessary to consider how appropriate the use of the data is. Finally, the most important problem with the technology currently is expectations; developers of the software can hype up their products and make it seem as if they are the answer to all questions of ecological surveying. It is important for users to know the limitations and use the technology appropriately (Fassnacht et al., 2005).

The study made use of geographical information systems software to spatially analyze the studied areas. Using satellite imagery groups made a comparison between the years 2003, 2005, 2006, 2007, 2006, and 2011. The maps that were created for these years showed the land use practices for the study area, allowing us to quantify the changes in land use over the years. The main focus of this mapping exercise was to determine the change in the percent impervious surface and the increase in the urbanization and human impact in the area. As mentioned earlier, the increase in the intensity of human activities a predominate factor in the pollution of water systems. With information on the increase in the amount of impervious surfaces in various areas of the watershed since the initial study, it is possible for us to demonstrate this relationship.

Landscape Ecology

Just as important as the relationships between human land use and the water systems is the relationship between the particular species in the water systems. Landscape ecology is a science that focuses on the reciprocal interactions between ecological processes and spatial patterns (Turner, 2005). This requires an in depth focus on the heterogeneity, the “complexity or variability in a system property of interest in space and time” (Reynolds, 1995). The field really began its transition into what it is today in the 1980’s as spatial data and analysis methods more widely available, leading to the methods produced being used by many branches of ecological study and influencing the management of both natural and human dominated landscapes. The patterns studied in landscape ecology are the result of several different factors both biotic and abiotic, and the human effect as well. The abiotic factors include climate and landform whereas the biotic factors include factors such as predation, herbivory, and competition. Also, the ways in which humans make use of land is a key driver in landscape patterns.

Being in a reciprocal relationship, organisms in an environment have an effect on landscape heterogeneity and vice versa. The behavior of organisms in a given environment plays a great role in shaping the environment in which they live, for example the feeding patterns of hippopotami creating canals that determine the flow of water and the movements of other species. The effects of organisms on the landscape heterogeneity are understudied. The reverse, however, has been studied at great lengths as landscape ecologists set out to prove how organisms live, reproduce, interact, and disperse based on the landscape heterogeneity.

In order to clarify relationships between ecological processes and spatial patterns it is first necessary to quantify the spatial heterogeneity of the data. Because of this relationship, a major focus in landscape ecology is the measurement, analysis, and interpretation of spatial patterns (Turner, 2005).There are several dedicated software programs to aid in the analysis of this information. Over the past twenty years landscape ecology and the methods and templates for determining the interactions between ecological processes and spatial patterns, as well as the importance of these processes, has become well integrated within the ecological sciences. With its discovered importance it will continue to grow and help shape ecology science in the future (Turner, 2005).

WATER QUALITY

As stated earlier, the most significant measurable impact on water quality comes from an increase in the intensity of human activities in a given area. Water quality is most predominately affected by changes in land use practices in these areas as transitions are made from natural ecosystems to highly urbanized or agricultural areas. It is necessary to make steps towards remediation of the problems at hand as well as to establish methods for prevention of these issues in the future. Organizations like Adopt-A-Stream and local community groups like the Watershed Alliance of Sandy Springs are ideal to go about this process. By getting the affected public educated on the problems at hand and involved in the correction process it is possible to make real lasting change in the land use practices that are currently in place.

STUDY SITES

Long Island Watershed is located in Sandy Springs, a municipality of Fulton County Georgia. Sandy Springs was incorporated in December of 2005 and the watershed was previously under Fulton County provision. The headwaters are located near Kayron Drive at site 1 on the map in Figure 1. The watershed as a whole is relatively forested with some residential sites. However, the headwaters and upper one third of the watershed is mainly dominated by urbanization including major roadways as well as commercial and residential areas. Further downstream, the watershed is mainly forested residential and transitions into forest when it passes into the Chattahoochee River National Recreation

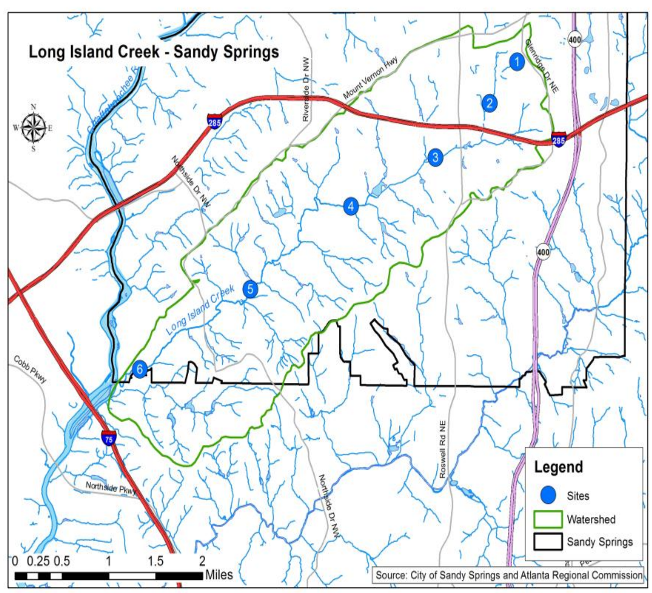

Figure 1: Long Island Creek, Sandy Springs

Area before the creek flows into the Chattahoochee River. This compares to the previous study performed in 2001 (Harper, 2001). Figure 4 shows various pictures representative of the watershed as it transitions from the urban upstream to the forested downstream.

In the previous study, Harper discovered that the upper one third of the watershed was the main concentration of impervious surface. The impervious surface was calculated at 15.853% for Harper's study of the watershed ten years ago (Harper, 2001). In the current assessment of the watershed, the impervious surface is 29.42%. This is an increase that needs to be recognized since the river is now at the limit from being "Impacted" to being "Degraded". The reason for the increase in impervious surface is due to an increase in road surfaces, commercial sites, and high-density residential sites. The major increases in impervious surfaces are seen in roadways as well as commercial sites.

The current study was performed by a group of students at Kennesaw State University, separated into six different sites along the creek. The site locations, as well as the watershed as a whole, can be seen in Figure 1. As seen in the map, the sites were strategically placed so that the watershed would be well represented by the data collected. The idea was to examine the difference in the water around the headwaters with the water in the urbanized areas as well as the water in residential areas and forested areas as it flows into the Chattahoochee River.

For the watershed as a whole, it is important to understand the discharge levels and air and water temperatures. The average discharge level of the watershed is 4.78 cfs/100 mL. As seen in Figure 2, the discharge mainly increases from the headwaters to where the creek flows into the Chattahoochee River with the exception being site 3A. Temperature, regardless of whether water or air is relatively the same. This can be observed in Figure 3 where it can also be seen that the only exception is a slight variance from the average water

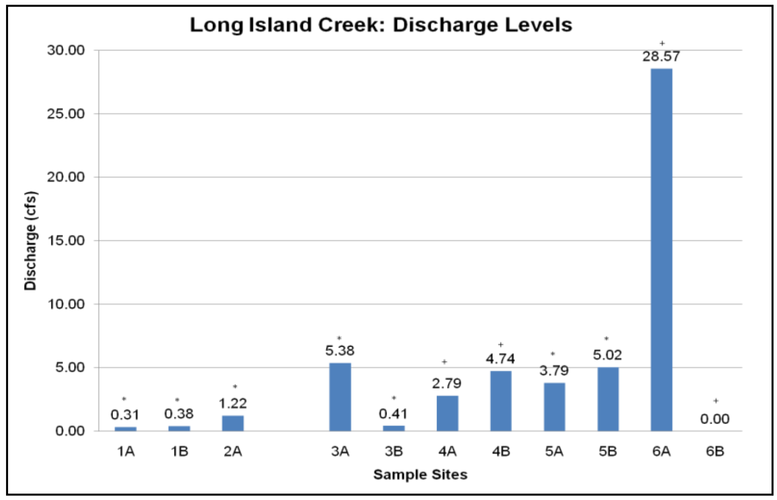

Figure 2: Long Island Creek: Discharge Level
The * refers to a measurement on June 16 and a + is a measurement from June 23. Note that no data was collected for 2B and 6B is 0.00 because it is a pool.

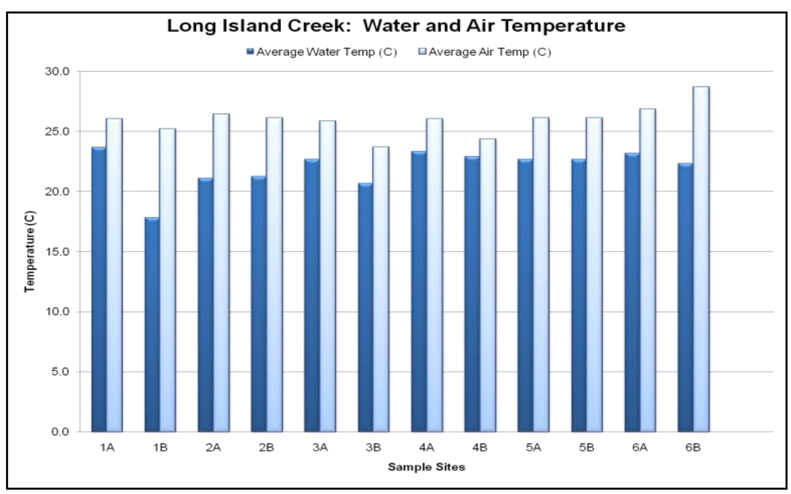

Figure 3: Long Island Creek: Water and Air

temperature at site 1B where the water temperature is 17 degrees Celsius. The average air temperature for the watershed is 25.8 degrees Celsius and the average water temperature is 22.3 degrees Celsius.

The first study sites selected were the headwaters of Long Island Creek within the city limits of Sandy Springs. The two streams are located just south of Johnson Ferry Rd NE and Glenridge Dr. NE. Residing in an older residential area of Sandy Springs the land is divided into individual parcels ranging from approximately one – two acres per parcel.

Site 1A, headwaters of the Long Island Creek watershed. The location is on a residential property on Kayron Dr. in Fulton County. Photo taken June 9, 2011.

Site 5A, located on a residential property off of Jett Road. Photo taken June 16, 2011.

Site 3A, located behind an apartment complex on Kingsport Drive NE. The site is a transitional section between residential and commercial regions of the Long Island Creek watershed. Site 3-A is near areas of heavy traffic and is densely populated. Photo taken June 6, 2011

Site 6A, the outflow of the Long Island Creek watershed into the Chattahoochee River. The location is a part of the Long Island Creek Park in the Chattahoochee River Recreational Area. Photo taken June 16, 2011.

Figure 4: Photos of Site 1A, 3A, 5A and 6A

Most plots are dominated by deciduous vegetation. The surrounding area remains fairly undeveloped compared to sites found to the south. However over the last five years there has been development at a few larger sites just north of Johnsons Ferry Rd., NE. According to citizens living within walking distance from sites, there has been substantial increase in runoff from these developed sites. While speaking with residents living in the neighborhood, people

have witnessed large amounts of runoff containing sediments, which they believe have come from these newly developed sites. These two separate tributaries where water samples were gathered are referred to as site 1A and 1B labeled as such in there progression West to East. Site 1A is located at the North end of Kayron Dr. The stream crosses Kayron Dr. and appears as a dry stream the majority of the year on the East side of the road. Large amounts of rip rap were placed on this side of the road to prevent sedimentation and stream bank widening. A culvert was constructed under the road to prevent erosion and possible failure. The stream exits the culvert and appears to have consistent, but light flowing water. There is a PVC pipe located beside the culvert which redirects water from the north after rainfall events. Early in the assessment of the stream it was noted that there had been considerable erosion above the culvert. This was most likely due to over flow from the road. Approximately five years ago the homeowner, on whose property the stream exists, built a wall on the north side of the stream. The wall is constructed of two trees that were used as a retaining wall to prevent further steam bank erosion.

Site 1B is a second headwater tributary roughly half a mile southeast of site A and is located on the West side of Lorell Terrace. Similar to site A the stream appears as a dry bed on the East side of the road where it enters a culvert. The culvert exits into a Six foot deep trench which, again as in site A, makes up the property line of two residential homes. The creek is unperceivable from the road and up close is almost entirely obscured by thick vegetation. This deep trench is marked by undercutting only perceptible upon climbing into the creek. Features of note include steep and narrow creek profile, debris strewn about, and severe undercutting.

Site 2A is located in a residential area and off of a residential road. Within the area examined there is a substantial overgrowth of *Pueraria lobata*, also known as Kudzu, which plays a large role in the health of the stream. Also within the area studied there is residential fencing that houses multiple dogs and is within 5 feet of the stream. Another item of concern is the large sewer pipe that runs directly through site A and down the culvert connected to site B.

Site 2B is located directly across the same residential road and demonstrates many of the same properties as Site A. The Kudzu overgrowth controls much of the landscape compromising the health of natural vegetation. Within the area studied there is one residential fence housing a domesticated dog uphill of the stream. Another area of concern is at the end of the culvert, beginning of Site B, there is a large pool with heavy silt causing concern for the stream.

Site 4 is located is the middle stretch of the stream length from the headwaters to the Chattahoochee River. The surrounding area is a low density residential neighborhood. The site is located in the backyard of a home off Glencastle Drive. Site 4A and 4B are approximately 100 feet apart, yet very different types of flow. Site 4A is a pooled area with a higher water volume and located downstream from site B, while 4B is a run with sporadic riffles and a very shallow water volume.

The most obvious and immediate threat to this site is runoff and pollution from the surrounding homes. Both sample sites have two unmarked pipes that deposit from the yards of the homes into the stream and one large culvert ten feet downstream from site A. Both sample sites are heavily vegetated with a high percentage of erosion on both banks.

The final location selected for the Long Island Creek watershed study is located in the Chattahoochee River National Recreation Area, East Palisades Whitewater branch. It is at site 6 where the Long Island Creek drains into the Chattahoochee River. This area is part of the National Park Service, and it is used by the general public due to its easy access to the creek, river and trails. This heavily forested area is one of the few places in metro Atlanta that remains

in a natural state, completely undisturbed by human activities except for hiking trails and small foot bridges.

Though human impact is limited, nature has not been as kind, recent storms and flooding have left evident damage to the local ecosystem. Numerous fallen mature trees of various species can be observed within the sample site areas with signs of exposed roots, leading to the belief that strong wings have plagued the area. The increasing urbanization surrounding the watershed and an increase of impervious surface area is suspected to be the cause of frequent flash flooding and runoff. The stream susceptibility to flash flooding has led to severely undercut banks and increased sediment deposits.

The study of site 6 consisted of two sample sites which were chosen within the stream reach for being representative of the area. Site 6A is located approximately 450 feet upstream from the pedestrian bridge adjacent to the parking lot. It is at a free flowing, rocky bottomed section of the creek with frequent riffles and runs and light siltation along the rock bottom. Site 6B is located approximately 25 feet downstream of the same pedestrian bridge where water flows through a series of slow runs and often stagnant pools leading into the Chattahoochee River.

METHODS

The study area was comprised of six carefully selected locations consisting of 2 sites in the Long Island Creek watershed in Sandy Springs, Georgia. At each site, determine the water quality of Long Island Creek by testing for the following bacterial parameters, including *E. coli* and Fecal Coliform. Chemical parameters were tested, including: nitrates, phosphates, and pH. Lastly, physical parameters, consisting of temperature, dissolved oxygen, and conductivity were established. In addition to water tests, a community index of vegetation was compiled within and adjacent to Long Island Creek watershed. Land use patterns were determined for the previous ten years. Studies were also completed on stream channel characteristics and fish species inventory within the study sites.

Bacterial Parameters

Students conducted tests according to the guidelines set by the Georgia Adopt-A-Stream protocol and were supervised by Drs. Pullen and Patterson, who were certified by AAS to test for bacterial parameters. The water was tested for the bacteria *E. coli* and Fecal Coliform. Dates samples were collected on June 7th, 21st, and 23rd of 2011. Students used Whirl-paks to collect and hold water samples. Three samples were collected from each site to ensure consistent readings. The samples were collected from the same location at each site and students used gloves to protect each sample from contamination. After samples were collected, the Whirl-paks were labeled and placed on ice. Once back in the lab, each sample was placed on a 3M Petrifilm. All samples on Petrifilm were placed in an incubator at 35 degrees Celsius (+/- 1). After 24 hours, samples were removed from the incubators, at which point each film was inspected for blue to red-blue colonies that contained a gas bubble. These colonies were counted and divided

by the total number of samples was taken. These averages were multiplied by 100 to determine the number of colony forming units per 100 milliliters of water sample.

Chemical Parameters

To collect samples, students followed instruction from Cobb County Water Authority to test for chemical parameters (nitrates and phosphates). Students collected water midstream around one foot below the surface of the water. If water was less than one foot deep, water was collected one third of the way below the surface. Students collected samples at stream base flow. Water samples were placed on ice and taken back to the lab facility for testing; using the LaMotte nitrate and phosphate test kits. Two tests were run for each parameter. If the tests were not within ten percent of each other, students would run another test to ensure accuracy.

Physical Parameters

Students were certified by the AAS to perform water quality testing of physical parameters. These parameters included air and water temperatures, pH, dissolved oxygen, and conductivity. Air temperature was taken in the shade and temperature was recorded after appropriate time for stabilization. The temperature of the water was also taken in the shade, directly in the stream near the middle of the channel. When measuring dissolved oxygen, water samples were taken avoiding trapping bubbles or bubbling air into the sample (which may add dissolved oxygen). Samples were measured using the Georgia Adopt-A-Stream program guidelines. All samples were measured and recorded in milligrams per liter. A conductivity meter was used to measure and record the conductivity in microSiemens per centimeter (μs/cm) of the water in the watershed.

Community Index

Compiling a vegetation community index consisted of sampling twenty different tree species randomly in each of the six sites. Following the codes set forth by the USDA community tree evaluation, each species was judged on probability of failure, size of defective parts, and probability of target were evaluated. Cracks, decays, root problems, architecture, weak branch union, cankers, and physical obstruction were all taken into consideration to determine how at risk each tree was. Probability of failure was based on a scale from one to four points. One point would be considered low, meaning minor defects were present, and four points would be considered extremely high, with multiple and significant defects present. The probability of target impact was based on a scale of one to three. One would be occasional use areas, such as park trails and parking lots adjacent to low use areas. Three would be frequent use areas, such as emergency access routes and high use areas. In addition to these ratings, observations were made to determine any other variable dangers or hazards unique to each tree specimen. The

special hazards and dangers were described and noted, each of the three or four numerical ratings were added together to procure a final rating of the plant specimen. After a final judgment was made on the overall rating, the Diameter Breast Height, or DBH was taken to determine the diameter of the tree.

Land Use Patterns

Land use was of special concern in the analysis all of the research sites. It was mandatory to take into consideration the history of the Long Island Watershed over the past decade in order to develop an accurate assessment of past and current land use patterns and their effects on the changes throughout the watershed over time. Using an image from 2006 LANDSAT 7 imagery from the United States Geological Survey in the ERDAS Imagine 2010 software, students created land use maps of the watershed for the various years through remote sensing. From this, percentages of impervious surface cover and area for each of the 6 were calculated through Georgia Adopt-A-Stream guidelines.

Stream Channel Characteristics

In the determination of in-stream characteristics many factors were taken into consideration using the Georgia Adopt-A-Stream Visual Stream Survey guidelines. Stream reach was conducted by measuring the width of the channel and multiplying it by 12. Water flow takes into account the pools, riffles, and runs within the stream reach. After four runs of the ball, an average time was calculated. From then, the average time was divided by the length, 20-feet, to obtain the speed of travel. To calculate the area, depth measurements were made at eight different intervals. The sum of the measurements was divided by the total number of measurements to find the average depth. Additionally, width measurements were made along the stream in two increments. Just as the sum for average depth was calculated, the sum of the width measurements was divided by the total number of measurements. By multiplying the average width by the average depth, the area was calculated. To calculate the stream flow, students multiplied the area by the speed and by the coefficient. The coefficient varied as to the difference of the bottom, which is affected by whether it is rocky or muddy. The final stream flow was measured in cubic feet per second. Flow rate or discharge was determined by multiplying speed, average stream depth, and width. Speed was computed using a Ping-Pong ball and timing how long it took to travel 20 feet downstream Measuring the channel cross section refers to stretching a measuring tape across the stream and taking the measurement across the stream and the banks. All measurements were taken from left to right while facing downstream. Measurements began from the left bankfull to the right bankfull. Once a total measurement was made, additional measurements were made vertically every 2 feet to create a cross-sectional stream profile. Embeddedness, which is the degree to which rocks in the streambed are surrounded by sediment (AAS, 2008), was determined by students through observation of riffle areas in the streams. To determine organic material in the stream, students took a visual observation looking for logs, fallen trees or parts of tress, which could provide shelter and

structure for aquatic organisms. Students were also required to take note of any odors pertaining to the water and the surrounding areas, as well as any abnormal surface conditions such as oil sheen, film, or flock like deposits or foam. Visual observations were taken to determine the clarity of the water. Visual determination of bank erosion, including conditions such as undercut, step or gradual sloping, and soil integrity were also made. Visual biological survey was conducted in or around the stream to determine fish, aquatic plants, algae, and stream shade cover. Lastly, a sketch of the stream monitoring site was produced.

Fish Species Inventory

Fish inventory was led by Dr. William E. Ensign, a Professor of Biology at Kennesaw State University. This process involved the use of an electrical current to temporarily paralyze fish which enabled the collection, observation, and data gathering of fish. Equipment used for this portion of the study included a single DC pulsed backpack electro fishing unit (BPEF). Students donned waders, and carried nets and buckets to help Dr. Ensign collect and analyze the numerous fish species.

RESULTS

The data collected in this research was at times surprising and highly variant in some areas, which can mostly be attributed to the diverse makeup of the land cover and several weather occurrences, though it strengthens the belief that watersheds are very diverse and complex areas of ecosystem that deserves deeper research. The small watershed, Long Island Creek Watershed, is only but a small tributary of the Upper Chattahoochee Watershed, which only furthers this notion of complexity.

Table 1: Percent of impervious surface in Long Island Creek Watershed (as based on ARC impervious quotients)

	Classes						TOTAL
Year	Water	Road	Commercial	Forest	Residential	Apartment/ Townhouse	% impervious surface in watershed
2003	0.00	3.50	8.30	0.25	3.70	1.50	17.25
2005	0.00	3.10	2.60	0.21	6.20	12.40	24.51
2006	0.00	6.80	2.40	0.40	1.20	1.00	11.80
2007	0.00	9.50	1.30	0.26	0.23	8.70	19.99
2009	0.00	0.81	18.70	0.36	0.06	0.00	19.93
2011	0.00	11.40	9.10	0.12	4.30	4.50	29.42

According to Table 1, land cover in the past decade has varied greatly ranging from 11.8% impervious surface to 29.42% impervious surface. The expected trend would be impervious surfaces gradually increasing from the earliest images starting with Figure 5, to coincide with the growth of the area. This was in fact not the case as the classes had spikes in many years with decline in others. This can be interpreted to mean that with such rapid growth, areas change constantly. What was once forested area in 2003 (Figure 5) could have been cleared and be interpreted as commercial in 2005 (Figure 6) due to construction, while in 2007 (Figure 8) this area is now residential after the homes have been built and the large undeveloped areas now filled. This watershed is under constant change and the impervious surface percentage fluctuations reflect this.

Remote Sensing Results

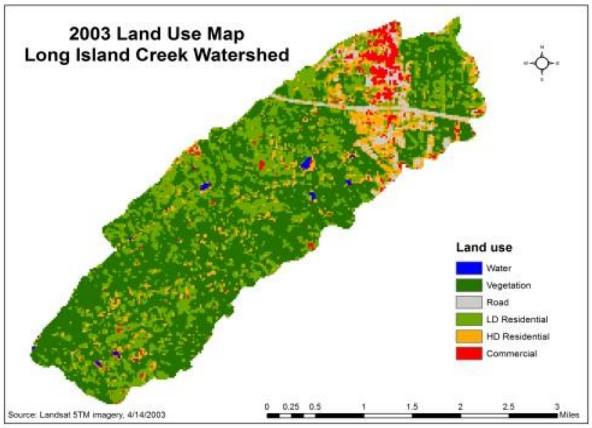

Figure 5: 2003 Land Use Map

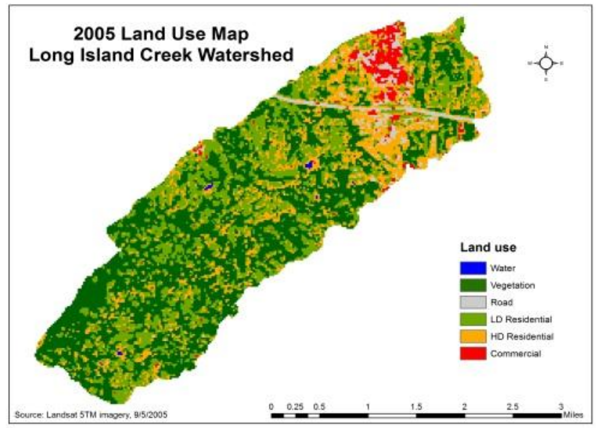

Figure 6: 2005 Land Use Map

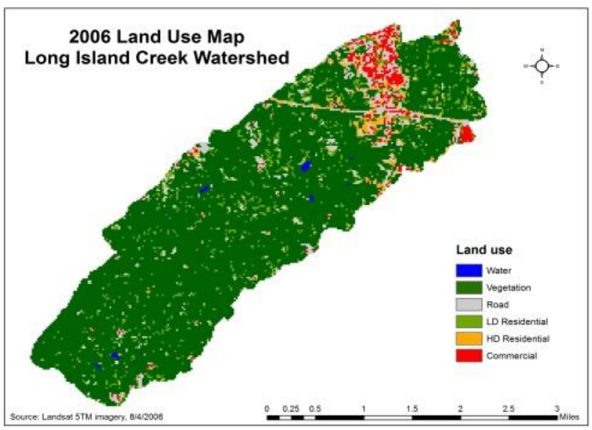

Figure 7: 2006 Land Use Map

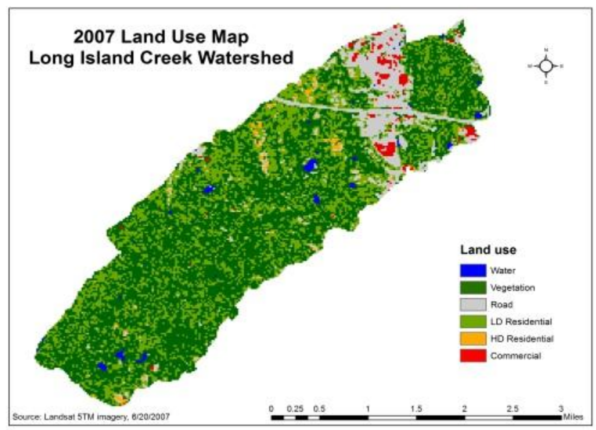

Figure 8: 2007 Land Use Map

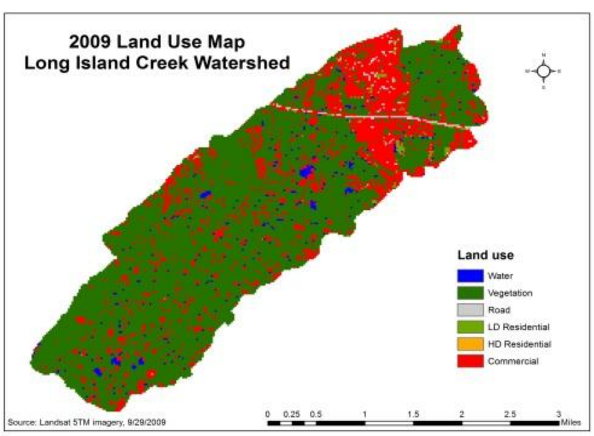

Figure 9: 2009 Land Use Map

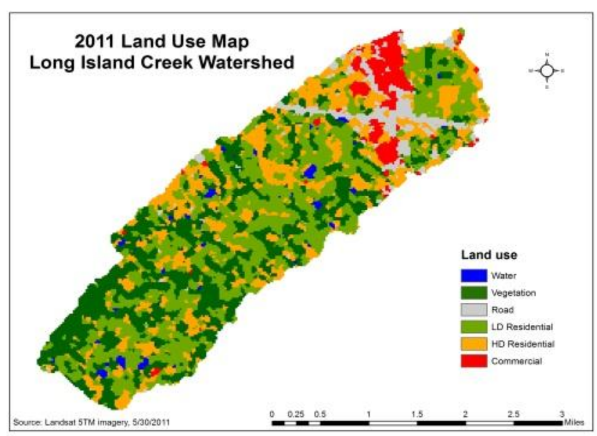

Figure 10: 2011 Land Use Map

Chemical Results

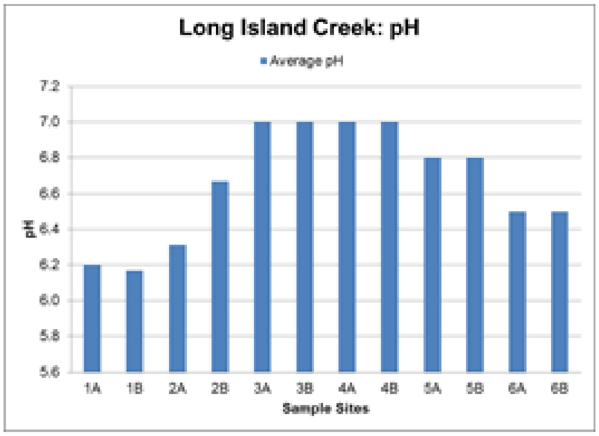

Figure 11: Long Island Creek pH Level

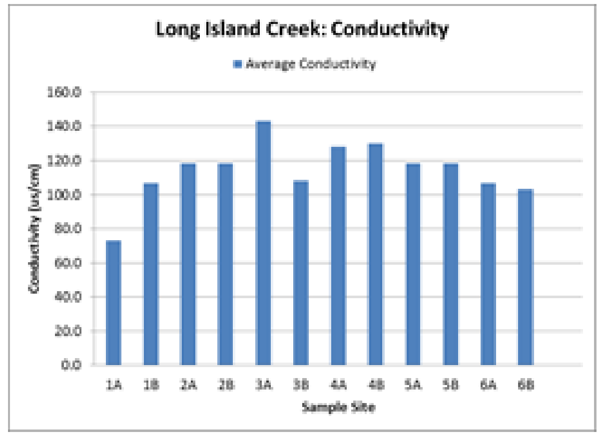

Figure 12: Long Island Creek Conductivity

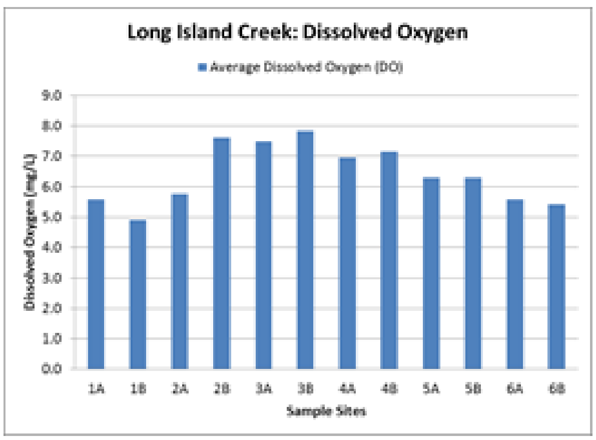

Figure 13: Long Island Creek Dissolved Oxygen

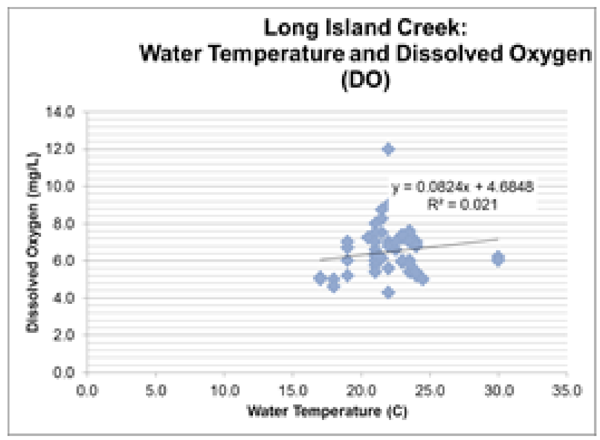

Figure 14: Long Island Creek
Water Temperature and Dissolved Oxygen

Sites*	Nitrate (mg/L) max	Nitrate (mg/L) min	Nitrate (mg/L) average	Phosphate (mg/L) max	Phosphate (mg/L) min	Phosphate (mg/L) average
1A*	0.25	0.05	*0.18*	<1	<1	*<1*
1B*	1.50	0.05	*0.68*	<1	<1	*<1*
2A	2.00	0.00	*0.63*	<1	<1	*<1*
2B	2.00	0.00	*0.88*	<1	<1	*<1*
3A	1.00	0.00	*0.50*	<1	<1	*<1*
3B	0.25	0.00	*0.13*	<1	<1	*<1*
4A	0.25	0.25	*0.25*	3	1	*2*
4B	0.25	0.25	*0.25*	2	<1	*<1 - 2*
5A	0.25	0	*0.13*	<1	0.00	*<1*
5B	0.25	0	*0.13*	<1	0.00	*<1*
6A	0.25	0	*0.13*	<1	0.00	*<1*
6B	0.25	0	*0.13*	<1	0.00	*<1*

*n = 6 collected over 3 days; all other are n =4 collected over 2 days

Table 2: Nitrate and Phosphate Results

The chemical results for this study were somewhat underwhelming in terms of their ability to make specific trends visible. The level of pH (Figure 11) remained nearly consistent throughout, with the largest variance from neutral being 6.2 at site 1A. The trend you see with pH is that it starts slightly acidic at site 1, normalizes around sites 3 and 4 and returns back to slightly acidic towards site 6. This is most likely attributed to the surroundings of the locations of the actual sample sites. Sites 3, 4 and 5 were located in backyards and thus further from sources of pollution which

might change pH levels, whereas site 1, 2 and 6 were either in areas very near urbanization, roads or public accessible. Conductivity levels (Figure 12) remained stable and consistent after site 1. Site 1 was, for all intents and purposes the very beginning of the stream flow, making it lower in conductivity because it has not yet had the opportunity to pick up additional metals to increase the water's conductivity. The majority of the sites were in the acceptable range for dissolved oxygen content of the water. This supports the observation of strong fish communities throughout the stream. The only area of concern for the dissolved oxygen levels is site 1 (Figure 13), which can again possibly be attributed to it being source of the stream and not yet going through enough riffles to obtain an acceptable level of oxygen, but the level was not too far to be of high concern (Figure 14). The chemical test most indicative of impairment was the nitrate and phosphate tests (Table 2). Nitrates saw a surge from site 1A all the way through site 3A, after which it falls to a level that is nearly undetectable. This is likely best attributed to the locations of these streams to areas which see large amounts of organic debris such as grass clippings from landscaping or sediment from construction sites. The drop off in nitrate levels at 3B marks the area of the stream that enters more private sections of the stream which are generally only accessible through residential sections, thus less tended to and more forested so you would not see as much of this organic debris. The phosphate levels are consistently low throughout the watershed with the exception of site 4, which has a large drainage pipe installed from the low point of the backyard (that the sample site 4 sits on) to the stream. The drainage pipe collects and concentrates the phosphates from fertilizers used in the yard directly to the sample sites.

Bacterial Results

Table 3: ***E. coli*** **Results**
"." = no sample taken
TNTC = Too many to count
Each result is an average of n=3

	E. coli (cfu/100mL)			
Sites	7-Jun-2011	9-Jun-2011	21-Jun-2011	23-Jun-2011
1A	733	-	TNTC	-
1B	900	-	2000	-
2A	-	633	4133	2850
2B	-	-	1733	2733
3A	1267	-	-	4900
3B	400	-	-	1200
4A	933	-	-	4200
4B	833	-	-	4166
5A	967	-	1500	-
5B	600	-	1133	-
6A	1467	-	1367	-
6B	-	0	2933	-

The cause for alarm on this stream is certainly the *E. coli* levels. (Table 3) The water quality standard for full body contact recreation in Georgia is based on *E. coli*, as recommended by the EPA. For water to meet the recreation standards, the geometric mean of samples over a 30-day period is required to be less than 125 cfu/100mL, with no sample testing higher than 235 cfu/100mL. The highest level of *E. coli* measured "too numerous to count" and was taken at site 1 after a heavy rainfall. It is likely that there is a nearby sewage leak into the water table that site 1 feeds from. Site 1 being the origin of flow, it stands to reason that the rest of the sites would be quite high as well, and they are, but you see a sharp decline after site 1 with levels which are at lowest twice as much as the acceptable level for full body contact. High levels of *E. coli* relate to pollution as well as fecal waste, and indicate a strong impairment to biological chemistry. Three samples were collected, but one resulted in error from incubators and only two per site were used.

Fish Species Inventory Results

Animal species play important roles within stream ecosystems. Fish species in particular are fantastic indicators of overall health of such a system because groups were able to assess the overall stream health, to some degree, by assessing the health of fish communities sampled from multiple stream reaches. This can be described as biotic integrity, which according to Karr and Dudley, as "the ability to support and maintain a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of the natural habitat of the region." Basically, this means that research groups should be able to directly attribute biotic factors, in this case fish communities, to the overall health of a stream. Advantages to using fish as biotic indicators include being relatively easy to identify to species, they have extended life spans compared to most benthic invertebrates and therefore longer life histories are available, and fish cover a large range of trophic levels within a food web as well as they are generally at the top of said food webs. IBI metrics, or the Index of Biotic Integrity, were designed as a simple way to assess the biotic integrity of a stream by assigning scores to certain metrics. Such metrics used in determining the IBI score are the number of native fish species found and the number of specific species that occupy particular niches, which in a healthy stream one would expect to find. Other metrics are important as well and will be more specifically described. The purpose of the scoring is to provide a ranking of excellent, good, fair, poor or very poor.

Table 4: Long Island Creek Fish Species
Summary of fish species collected in Long Island Creek on Jun 11, 2011

Scientific Name	Common Name	Abundance	Tolerance	Feeding	Specialty Category
Campostoma pauciradii	Bluefin stoneroller	12		Herbivore	
Nocomis leptocephalus	Bluehead chub	4		Omnivore	
Pimephales promelas	Fathead minnow	2		Omnivore	
Semotilus thoreauianus	Dixie chub	5		Omnivore	
Hypentelium etowanum	Alabama hogsucker	2		Insectivore	Round Bodied Sucker
Ameiurus brunneus	Snail bullhead	1		Omnivore	
Ameiurus natalis	Yellow bullhead	5		Omnivore	
Fundulus stellifer	Southern studfish	44	Intolerant	Insectivore	
Lepomis auritus	Redbreast sunfish	13		Insectivore	Sunfish
Lepomis macrochirus	Bluegill sunfish	7		Insectivore	Sunfish
Micropterus salmoides	Largemouth bass	1		Piscivore	Centrarchidae
Percina nigrofasciata	Blackbanded darter	9		Insectivore	Benthic Invertivore

A reach of Long Island Creek measuring approximately 75 meters in length was sampled. As seen in Table 4, there were 12 species of fish collected with a total of 105 fish being sampled. This is a rather low number of species that would be expected to be found at such a site and therefore it can be assumed that the overall stream health is poor. The most abundant species found, however, was the *Fundulus stellifer*, commonly known as the Southern Studfish, which is considered an intolerant species. Intolerant species are good indicators of stream health as they require more specific conditions than tolerant species and therefore the large quantity of Southern studfish would lead one to assess that this particular reach of stream is in good health. Another indicator of good health is several insectivore species: the Southern studfish, Redbreast sunfish, Bluegill sunfish, Blackbanded darter and Alabama hogsucker. This indicates that there are enough invertebrates to sustain these populations. The IBI scoring, however, does not agree with the assumptions made solely from the species list.

Table 5: **Index of Biotic Integrity**

Summary of IBI of the Long Island Creek stretch sampled on Jun 21, 2011

IBI Metrics	Metric Score (1, 3 or 5)
Number of Native Species	3
Number of Benthic Invertivore Species	1
Number of Native Sunfish Species	3
Native Insectivorous Cyprinid Species	1
Round-bodied sucker Species	1
Head-water Intolerant Species	1
Species Evenness	5
Percent of Fish as *Lepomis* species	5
Percent of Fish as Insectivorous Cyprinids	1
Percent of Fish as Generalists or Herbivores	3
Percent of Fish as Benthic Fluvial Specialists	1
Number of Individuals per 200 m of stream	1
DELT Anomalies	0
Overall IBI SCORE (Range is 8 - 60)	26
IBI Narrative Rank (Very Poor, Poor, Fair, Good or Excellent)	Poor

The IBI scores assigned to the above metrics are based on the Georgia Department of Natural Resources protocols used in the Chattahoochee River basin located in the Georgia Piedmont Eco region with a watershed area less than 15 square miles. The metrics in Table 5 are scored based on a 1, 3, 5 scale with 1 being a low score and 5 being the best scoring. As shown, only two metrics received a score of 5 while the highest frequency scoring is a 1. By adding each of the metric's scores together an overall score of 26 was obtained, which ranks this stream as poor according to the Georgia DNR. The assumptions based only on species found were incorrect because the quantities of those species were not considered as they are when scoring the IBI metrics. The Index of Biotic Integrity is the most accurate way of assessing overall stream health because it takes into account multiple criteria while providing fair scoring methods.

STUDY SITE RESULTS

Site 1

Site 1, June 21, 2011

Site 1 is comprised of two separate head-water streams. The two sample sites, referred to as sites 1A and 1B are both located in a residential neighborhood comprised of similar single family homes on lots ranging from one-half acre to two-acres in size. Both streams are perennial and share the feature of a culvert running through them. The two were selected for their similarity and proximity, being roughly one-half mile apart latitudinal. Both streams are at the low point where water runs into the catch basin. All the runoff water eventually makes its way into the low points. There were multiple factors that affected the streams including impervious surfaces, nitrate and phosphate runoff from yards, and sewer lines.

Site 1A was located at a home at 6126 Kayron Drive and flows East to West. A culvert that runs under the street is where the first signs of water flow can be noticed. Unless there is a heavy rainfall, the amount of flow in this stream is very minimal. In addition to the flow that comes under the road, a 6 inch PVC overflow pipe brings in runoff from the areas that are at higher elevations. The stream has an average depth of 1.72 inches and an average width of 192 inches. The average CFS flow is 1.16 on June 16th. The average amount of nitrate in the water was .18 mg/L and phosphate levels were less than 1 mg/L (Table 2). The *E. coli* on June 7 was 733 cfu/100mL, and after the rain on June 21 the levels were too numerous to count (Table 3). The average air temperature is 26 degrees Celsius, and the average water temperature was 23.7 degrees Celsius (Figure 3). The pH count for site 1A was 6.2, which was slightly lower the than the other site measurements (Figure 11). The average conductivity was 73.3 µs/cm, which was

the lowest conductivity recorded among all the sites (Figure 12). The average Dissolved Oxygen level for site 1A was 5.6 mg/L (Figure 13). Finally, the stream discharge for site 1A was .31 cfs/100 mL (Figure 2).

Site 1B, located at 593 Lorell Terrace, flows East to West as does site 1A. A culvert exit also defines where one starts to see flow. The culvert is covered with vegetation, and the stream could not be easily accessed. The stream exits the culvert and runs along the bottom of a 4 to 6 foot walled stream bank. The estimated stream length is 120 feet from the culvert to the fence in the backyard where the stream flows into the wooded area to the west. The stream has an average depth of 1.94 inches and an average width of 144.5 inches. The average flow is .68 cfs/100 mL. These results can best be explained by the presence of a half dozen pools at the stream head and the rocky stream bottom. While a measurable depth is present in the pools, the only visible flow is too far downstream to be accurately assessed. The majority of water flow in this area is largely due to groundwater and runoff from the surrounding yards. The average nitrate level in the water for site 1B is .68 mg/L and phosphate levels are less than 1 mg/L (Table 2). The *E. coli* level on June 7th was 900 cfu/100mL and slightly increased after rainfall on June 21st to 2000 cfu/100mL (Table 3).The average air temperature is 25.2 degrees Celsius and the average water temperature is 17.8 degrees Celsius (Figure 3). The pH for site B was the same as site A (Figure 11). The average conductivity was 106.7µs/cm for this site (Figure 12). The average dissolved oxygen levels for site B was 4.9 mg/L (Figure 13). Finally, the stream discharge for site B was .38 cfs/100mL (Figure 2).

For site 1A and 1B, 10 trees were assessed for each site. There was a requirement to have 5 different species at each site. For 1A, nine different species were identified out of the ten trees that were analyzed. Out of all the trees, only two of the trees had a risk rating above 4. The average DBH for all of the trees in 1A is 35.6 (Figure A1). For 1B, seven different species were identified out of the ten trees that were analyzed. The average DBH for all the trees in 1B is 23.6 (Figure A2). The surrounding area around and above Site B is dominated by low shrubs. On the cross section for site 1A, rocks and vegetation hold up the left side (Figure A3). The right side was held up by landscape timber (Figure A3). On the cross section for site 1B, the left side was a steep slope with severe undercutting, and the right side was mild to steeply sloped and covered with vegetation (Figure A4). On June 16, which was the second visit to site 1B, six old growth trees had been removed, and there was evidence of on-site pulping. No aquatic plants or algae were present in the stream because water is not present in the stream year round. The largest visible concern was extreme undercutting along the aforementioned shear bank. At some places, the undercut could be measured over a two feet and running five feet in length. This was punctuated by washout areas located at points along the northern bank. Overall, the two sites had a great deal of similarities. Both streams' visual appearances are very similar, and the flow rates are similar in both sites.

Site 2

Site 2, June 21, 2011

Site 2 is located off of Hildebrand Road in Sandy Springs. Throughout the sites there were a number of factors that impacted the watershed such as a residential road, commercial land use close by, multiple domesticated animals, sewer drains and a large culvert, which linked the two sites together. Overall site 2 of the Long Island Creek Watershed had an average of 24.51 % of impervious surface. Nitrate levels around the area had an average of 0.63-0.88(mg/L). Phosphate level averaged <1 for both locations, and *E. coli* was measured and showed three different levels which were 633, 4133, and 1733(cfu/100mL).

Upon examining site A which is located along a residential road, the group discovered that the homeowner closest to the stream had at least five larger breed dogs, which were constantly found outside while doing this study. The dogs were found to be of importance in that the fence was located within five feet of the stream at some points, which contributes to large amounts of fecal matter being deposited into the streams after a heavy or light rainstorm. Site analysis revealed a large sewer pipe that runs directly along the middle of the stream. Although the pipe did not seem to have any obvious breaks or leaks, the pipe looked fatigued and rusted and in some points had a large covering of algae/slick substance. Over the course of the next few years, this pipe may need to be changed in order to keep sewage from interring the stream due to breakage and fatigue. The large culvert located on this site appeared to be in good shape, however there were a few areas that had obviously been exposed to the elements over the years and were starting to show signs of wear and tear i.e. corners cracked, discoloration on exposed sides, and large chunks of cement lying in bottom of culvert.

After exploring the areas surrounded by site B, which is also surrounded by a residential road, a similar commonality of domesticated animals near the stream was found. Although the

fenced area was further away from direct contact, there was a gradual decline of elevation, which would produce a good deal of run off into the stream after a good rainstorm. This area is also heavily taken over by invasive *Pueraria lobata*, or commonly known as Kudzu. More than ninety percent of the vegetation in and around the area, which included a variety of Oaks (*Quercus* family), Loblolly Pines (*Pinus taeda*), and Tulip Poplars (*Liriodendron tulipifera*), was either completely covered or was beginning to be taken over and covered by Kudzu. Both site A and B had similar varieties of vegetation both native and introduced, while both were being overrun with the Kudzu growth. At the end of the culvert, or site B which is downstream of site A, a large stagnant deep pool was found to have a much silted bottom. Further downstream, the water had a much harder time flowing due to the amount of rocks in and around the stream bank. The rocks that were found in the stream appeared to have been placed to help with erosion, however after larger amounts of flowing water came through the rocks were moved into the stream.

This study revealed a high level of impervious surface in and around the area which impacts the Long Island Creek Watershed. The average percent of impervious surface was 24.51. This high percentage of impervious surfaces dictates the important of classifications. The remote sensing analysis showed the following percentages of impervious surface; road 3.10 %, commercial 2.60 %, forest 0.21 %, residential 6.20 %, and apartment/town home came in at 12.40 %. This study site had the second highest percentage of impervious surfaces next to site six which had 29.42 % impervious surface.

The Georgia Department of Natural Resources (DNR) currently ranks impervious surfaces in a watershed as the following: <10% “Protected”, 10 to <30% “Impacted” if not mitigated, and >30% “Degraded” if not mitigated. Within this classification site two of the Long Island Creek Watershed is “Impacted” if not mitigated. With the main use of this area being apartment/town home and residential use, it is important to closely monitor the surface water and runoff that is currently contaminating the watershed.

Nitrate levels were also examined over the course of the study. The maximum level the group discovered for site A was to be 2.00mg/L whereas the minimum was 0.00mg/L, which led to an average of 0.63mg/L. Similarly on site B, the maximum level was 2.00mg/L the minimum was 0.00mg/L and the average was 0.88mg/L. Upon examination of the other groups it was discovered that this study site had the largest amount of nitrates in the watershed. A study of the Phosphates in the area was also conducted over this course study. Phosphate levels for both site A and B ranked on average with the rest of the study sites to be an average of <1. Phosphate levels did not seem to be a major worry throughout the area, as the watershed overall showed a pretty low number <1.

One of the more serious items that was studied throughout this research was the amount of *E. coli* that could be found throughout the Long Island Creek Watershed. Site two A found an average of 633cfu/100mL on June 9th 2011, an average of 4133cfu/100mL on June 21st 2011, and an average of 3433.33 cfu/100mL on June 23rd 2011. Due to a few irregularities, *E. coli* levels for site B was performed on June 21st 2011, which showed an average of 1733 cfu/100mL and June 23rd 2011, which showed an average of 3967 cfu/100mL. Although these numbers seem to be high, they are on average consistent with other sites in and around the watershed.

Site 3

Site 3, June 16, 2011

Site 3 is located near the Interstate 285 and Roswell road intersection in the city of Sandy Springs. Site 3A is located in a heavy residential area. Its tributary is inside an apartment complex. The apartment complex and surrounding stores create much run-off towards the stream. Compared to site 3B it is easy to see the quality of drainage in this complex is lacking some needed safety precautions that would insure a healthier watershed. Site 3A is completely surrounded by impervious surfaces and no doubt is a contributor to the highest percentage of imperious surface in the Long Island Watershed (Table 1). There is cement, black top, or parking areas close the natural beauty of the site (Figure C1). The land use in this area did not seem to take nature into account when the planning and development was taking place and that fact is readily apparent when viewing the surroundings of the site and natures benefits of the human occupation. The site is located underneath a bridge (Figure C1). The fact of the location being near a bridge creates a concern for sedimentation and siltation. The bridge is supported by steel pillars anchored in cement, which only adds to the already encroaching imperviousness that dominates this site. The site is compromised by the bridge in other ways as well. It seems the site is already being used as a dump by some local residents, but the bridge adds more to that litter pile. Table 3 shows evidence of this with the levels of *E. coli* being the 3rd highest in the Long Island Watershed. Figures 11 and 12 shows more of the impact humans have had on this location giving light to pH levels and conductivity respectively, which has to do with mineral and metal content, being tied for the highest in pH and the highest in conductivity out of all Site locations in this particular Long Island Watershed Study. There is an extreme drop-off where the flood-line appears to be and much steepness and unsettled terrain where the bank-fall lies (Figure

C3). This shows factual evidence of much erosion and massive run-off problems. There is no surprise in that fact when in observance of the sparseness of vegetation near the base and bank line. Trees near the stream are in peril. Some are infested with centipede colonies, others with cankers full of cancer, and still more almost completely decaying with little chance of recovery (Table C1). Each day there was new trash in the stream itself from ceramic dishes to children's bicycles to broken aquariums and then still broken glass highlighting the shore like sand covering a beach.

Site 3B is located approximately 300 yards southeast of site 3A. It does not hold the same tributary as its source for water. It is also not as close to an apartment complex as Site 3A although a more upscale complex is located nearby it does not nearly impede as much as Site 3A's surrounding complex. This site is flowing through a forest and has no bridge across it (Figure C2). Being as such, site 3B is not surrounded by nearly the amount of impervious surface area that contaminates the environment of site 3A. Site 3B is also not plagued by the problem of sedimentation or the infestation of cement coverage that the bridge supports required in the site 3A region. However, site 3B does its share of helping contribute to the site's impervious surface area and it seems as if site 3B will only increase its own impervious surface area when taking into account the continued construction nearby. Site 3B is nicely wooded (Table C2) and has a good blend of riffles, runs, and pools. There are, however, many signs of a run-off problem in the stream, which are evident when observing the path the water has formed through flooding, including mass erosion in the area and differentiation in flood-line, bank-fall, and base-line. Although the area appears nicer and the water quality is better when compared to site 3A, there are still negative notations that must be mentioned. There is potential for a major flow of contaminants as a sewage line travels over the stream, the stream does end in a stagnant drainage pipe giving ample probability of contaminant growth if it becomes present, and currently construction is taking place such that any number of negative impacts could result of this (least of all the eminency of improper land use in the creating of much increased impervious surface near the site). The flood line and bank fall of this site are noticeable, however, not nearly as severe (or covering a wider range of width than) the flood line and bank fall of site 3A (Figure C4). There is a large tree log spanning across the stream and beyond in a diagonal fashion not showing any need for immediate concern but if left unchecked could deteriorate and fall into the stream causing extreme blockage. Overall site 3B is much healthier of a watershed site than site 3A, although still having less severe problems of its own. Both site's phosphate and nitrate levels were not out of align with other site's showing no extreme variation or need for concern.

Looking at dissolved oxygen, in both sites and comparing their levels to the other sites in this study, Sites 3A and 3B have some of the healthiest amounts (Figure 13). This is a good influence to the site's biotic integrity, species variation, and numerosity within each species present. The level of dissolved oxygen in each of the Sites, 3A and 3B, came out higher than hypothesized. This is not to say that it is an accurate description of the health of the site. Site's 3A and 3B are in need of attention to their environment and surroundings, land use during urban growth and proper disposal of residential waste if humanity wants to help this site's percentage of probability for positive change to the Long Island Watershed.

Site 4

Site 4, June 21, 2011

Site 4 is located in the backyard of a home in a low density residential area off Glencastle Drive. In this section of the stream, the water flow is perennial. Though there are occasional bends from the natural flow, the site has a relatively straight stretch. At first glance the stream appears to be a healthy and clean aquatic environment. The site is full of wildlife including amphibians, reptiles, fish, and crustaceans. The banks are heavily vegetated, yet there are no aquatic plants in the stream reach. The fish were found to be from 1 to 6 inches in length. Samples were collected from two sites; 4A and 4B. Site 4B is upstream of site 4A. A surrounding 500 foot survey of the sites found 5 pools, 5 riffles, and 4 runs in this section of Long Island Creek. Between site 4A and 4B there is a bend that creates two pools. (Figure D1) Several sources of point source pollution were discovered, mostly from the residential property along the bank. There are many drainage pipes around site 4 that consolidate the runoff from the yards around the site (Figure D1). Articles found include lawn mower parts, fertilizer bags and generalized rubbish. Some areas were found to have stream bank restoration performed through the use of sandbags, though these efforts were likely causing more harm than their effectual function.

Site 4A is a pool that has an average depth of 1.05 feet with a channel width of 14 feet and an average flow rate of 65.75in/s (Figure D2). These measurement multiplied total a stream output of 4.02 cfs/100 mL (Figure D2). The stream bottom is half embedded with silt coverage over the entire width. On the south bank of site 4A erosion is a significant issue of concern (Figure D2) with rocks placed for remediation. The north bank has equally as bad erosion, yet

no action taken for remediation. Trees and other vegetation are becoming undercut and root exposure is common. There is a strong fish community in the deeper pool to the left of the sample site. Residents use site 4A as a source of recreation by fishing and swimming. Residents also frequently dispose of yard waste along stream bank.

Site 4B is a run that has an average depth of 0.14 feet that has a channel width of 16.02 feet and an average flow rate of 47in/s (Figure D2). These measurements provide us with a total stream output of 4.22 cfs/100mL (Figure 2). The majority of this area is a shallow run with sporadic riffles. The stream has a rocky bottom with very little silt deposition due to the faster stream flow compared site 4A. The north bank of this site is highly eroded with a vertical drop-off and 80% vegetation cover. The south bank is has a gradual slope with less erosion and 20% vegetation cover. On the north side the bank is highly undercut with most roots protruding from the ground. There is no visible fish community at the site due to the shallow water volume.

The average air temperature of site 4A is 26°C, with an average water temperature of 23°C, (Figure 3). While monitoring the stream there were no abnormalities in the pH levels all, findings were neutral (Figure 11). The finding for conductivity levels at site 4A range between 100µs/cm to 160µs/cm (Figure 12). Nitrate levels at site 4B were 0.25ml/g (Table 2). Dissolved oxygen levels stayed nearly to the same throughout the course (Figure 13). Phosphate levels of site 4A are much higher than expected ranging between 1mg/l to 3 mg/l (Table 2). This is because site 4 is in a high residential area, and chemical fertilizers are used for lawn care. *E. coli* levels on 14/6/2011 were 933 cfu/100ml, but on 23/6/2011 the totals had jumped to 4200 cfu/100ml (Table 3). The variation in the two days is because of a rain event the night before.

Site 4B has an average air temperature 24° C and an average water temperature of 23°C (Figure 3). Site 4B is in the shade which is the reason the average temperature is lower than site 4A. Levels of pH are neutral are site 4B (Figure 11). Nitrate levels were constant at both sites (Table 2). The Dissolved oxygen levels stayed constant throughout the experiment (Figure 13). The levels of phosphate at site 4B fluctuated from <1ml/g to 2ml/g in the stream which is most likely related to the rain the day before the second test (Table 2). Runoff from the residential yards is probably the main source of this change in phosphate levels. The *E. coli* results of site 4A were very similar to 4B. The first samples were 833 cfu/100ml, and the second sample was 4166 cfu/100ml (Table 3).

A community inventory was taken of twenty tree species surrounding the site. The predominant tree species are Sycamore, Box-elder, and Water Birch, which are all native to Georgia (Figure D3). The trees documented have a high variation for risk failure. The healthiest tree found has a risk rating of three where the only problem was a slight architectural problem. The worst tree found has a tree rating of ten with architectural, roots, canker and erosion problems. Over half the trees on the site had dead branches and all but two were found to have a risk of erosion due to its location to the river bank.

Even though there is impairment to the Long Island Creek site 4 is relatively healthy for an urban stream. The main concerns at site 4 are the phosphate, *E. coli*, and erosion. According to the Georgia Department of Natural Resources the amount of impervious surface near site 4 is impacted if not mitigated. Development near the Long Island Creek watershed has impacted the ecosystem near the stream, and has caused many of the less tolerant species of fish to be replaced with more tolerant species. The higher phosphate levels at site 4 can be attributed to the residential area that the site is in. Erosion is the most severe problem at site 4; since the stream is straight before the site it is susceptible to flash floods.

Site 5

Site 5, June 16, 2011

Site 5 is located within a light residential area consisting of two large grassy lots with few trees on one side and the other side consisting of several large lots containing slightly more tree cover. Jett road separates the site's two sample areas; with 5A being downstream and 5B being upstream of the bridge. As shown in the cross section diagram (Figure E1) this site had an average stream width of 15.5 ft., an average depth of 0.45 ft. which equated to an average flow rate of 4.41 cubic feet per second. The stream reach, wherein the two sample areas were located, was 245m in length and contained five pools, three riffles, and two runs and,

Samples were taken to determine pH, dissolved oxygen levels, nitrate and phosphate levels, and the presence of bacteria within the stream. Also measured were conductivity and both air and water temperatures. As expected, most measurements were fairly similar between the two sites with the exception of the bacteriological tests, which showed some difference. Sample site 5A occurred downstream from the bridge which should, in theory, increase the likelihood of contaminants being introduced into this part of the site. Tests performed supported this theory, as both test results confirmed higher levels of *E. coli* in site A. Another point of interest was the tree species found within the test sites, thus a tree risk assessment was performed utilizing a USDA Community Tree Risk Evaluation Form, which was also provided by Georgia Adopt-A-Stream. Overall, according to the Stream Habitat Survey from Georgia Adopt-A-Stream, site 5 received a Stream Habitat Score rating of fair.

Overall, the bacteriological results found higher levels of *E. coli* present in this section of the study area over those of area B. The results of the first set of measurements that were performed on June 7th, found 483 colony forming units, or cfu/100mL of the *E. coli* bacteria. Air

temperature was 31° C, water temperature was 24° C, pH was found to be fairly neutral at 6.8 ppm, dissolved oxygen was also measured at 6.8 ppm, and conductivity was 130 µS/cm.

The results of the second set of measurements were performed on June 21st and found even higher levels of *E. coli* than the first results. The number of colony forming units was determined to be 750 per 100 ml. In this instance air temperature was 25°C, water temperature was 23°C, pH was again 6.8 ppm, dissolved oxygen was reduced at 5.9 ppm, and conductivity was 120 µS/cm.

Overall the tree species found at this site were fairly healthy, with risk ratings ranging from 2-5 out of a maximum of 12. Species found included the Box Elder (ACNE), the Southern Red Oak (QUFA), the Flowering Dogwood (COFL), the Sweetgum (LIST), the Water Oak (QUNI), the White Poplar (POAL), the Black Cherry (PRSE), Loblolly Pine (PNTA), and American Sycamore (PLOC) (Figure E2).

The findings of the first set of measurements for 5B taken on June 7th found 300 cfu per 100ml at area B. Air temperature was 30° C, water temperature was 24° C, pH was fairly neutral and the same as 5A at 6.8 ppm, dissolved oxygen was again measured at 6.8 ppm as in 5A, and conductivity was slightly increased over 5A at 140 µS/cm.

The second sets of measurements for 5B were taken on June 21st. The results also found elevated levels of *E. coli* over the first set of tests. Levels were found to be 566.7 cfu/100mL. Air temperature was 26°C, water temperature was the same as 5A at 23°C, pH was again 6.8 ppm, dissolved oxygen was roughly the same as 5A at 6 ppm, and conductivity was again slightly higher at 130 µS/cm.

Several of the tree species identified at 5B had higher risk ratings ranging from 3-8 out of a maximum of 12. Three trees had a risk rating of 3, three had a rating of 5, and four were rated as 8. The higher risk ratings of site B are due to higher frequency of areas in this section where the bank is being eroded causing the roots of numerous trees to have an unstable anchor, resulting in some leaning at severe angles. Many of the same species found at site A were also found at site B, the representative species being the Box Elder (ACNE). Also found were the Mockernut Hickory (CATO), and the River or Black Birch (BENI) (Figure E3).

Overall, this study area appears to be primarily impacted by upstream events such as flooding and siltation resulting from increased levels of impervious surface discharge in these areas (Harper, 2001).

Site 6

Site 6, June 21, 2011

The final location selected for the Long Island Creek watershed study is located in the Chattahoochee River National Recreation Area, East Palisades Whitewater branch. It is at site 6 where the Long Island Creek drains into the Chattahoochee River. This area is part of the National Park Service, and it is used by the general public due to its easy access to the creek, river and trails. This heavily forested area is one of the few places in metro Atlanta that remains in a natural state, completely undisturbed by human activities except for hiking trails and small foot bridges.

Though human impact is limited, nature has not been as kind, recent storms and flooding have left evident damage to the local ecosystem. Numerous fallen mature trees of various species can be observed within the sample site areas with signs of exposed roots, leading to the belief that strong wings have plagued the area. The increasing urbanization surrounding the watershed and an increase of impervious surface area is suspected to be the cause of frequent flash flooding and runoff. The stream susceptibility to flash flooding has led to severely undercut banks and increased sediment deposits.

The study of site 6 consisted of two sample sites which were chosen within the stream reach for being representative of the area. Site 6A is located approximately 450 feet upstream from the pedestrian bridge adjacent to the parking lot. It is at a free flowing, rocky bottomed section of the creek with frequent riffles and runs and light siltation along the rock bottom. Site 6B is located approximately 25 feet downstream of the same pedestrian bridge where water flows through a series of slow runs and often stagnant pools leading into the Chattahoochee River.

As indicated in Figure 3, average water temperature for sample Site 6A for the days measured was 23.2° Celsius, and average air temperature was 26.8° Celsius. Average water and air temperatures for sample Site 6B had a wider range of results, measuring 22.3° Celsius and 28.7° Celsius respectively.

A number of factors might account for these disparities. Sampling site 6A is located in an area of dense tree canopy and shallow water depth. These physical characteristics contribute to lower air temperature and warmer water temperature accordingly. Sample site 6B, on the other hand, is situated in an area of low tree density, thus receiving more sunlight, which accounts for higher air temperature. This part of the creek is deeper, and covered by the pedestrian bridge, which contributes in part to the lower water temperature.

However, in order to further understand the implications of these temperatures to the biological community, measurements should be occasionally taken on consecutive days, and throughout the year because "thermal stress and shock can occur when water temperatures change more than 1 to 2 degrees Celsius in 24 hours" (AAS, nd).

Average pH for both sample sites were 6.5 (Figure 11). This is the lowest value within the range of optimal conditions for most aquatic organisms (AAS, nd). The average dissolved oxygen for site 6 was 5.6 mg/L for sample site 6A and 5.4 mg/L for sample site 6B (Figure 13). These dissolved oxygen levels fall within the healthy range specified for the biological community. According to Georgia Adopt-A-Stream, levels of 5 to 6 ppm (or mg/L) are required by most organisms for growth and activity (AAS, nd). Moreover, it is important to note that, during the summer organisms require more oxygen due to increased activity in warmer water (AAS, nd). The considerable presence of decaying organic material in the waters of site 6 decreases oxygen capacity, which might explain the lower average dissolved oxygen in comparison to most of the other sites.

Conductivity of the water in site six is 106.7μs/cm for sample site 6A, and 103.3 μs/cm for sample site 6B (Figure 12). Georgia Adopt-A-Stream states that conductivity range for rivers in Georgia is between 0 to 1500 μs/cm, and 50 to 50 μs/cm for "inland fresh waters […] supporting mixed fisheries" (AAS, nd). Therefore, site 6 conductivity levels are within an appropriate for biological communities.

Water samples were obtained from designated test sites on two separate occasions to test for nitrate and phosphate levels. Sampling occurred between 11:30 and 13:30 on both days and weather conditions were clear, having no precipitation within 24 hours. Sample sites 6A and 6B reported an average level of 0.13 mg/L for nitrate, and a level of < 1 mg/L for phosphate levels (Table 2).

Nitrate and phosphate levels found to be above 1 mg/L could, for example, indicate the presence of raw sewage, animal waste, and/or fertilizers. At this elevated level, the phosphate could encourage plant growth to the point of eutrophication which could cause oxygen depletion to take place (AAS, nd).

Bacteria monitoring was also included in the water quality testing. Samples were collected on different days from both sites and tested for the presence of *E. coli*. Sample site 6A averaged 1417 cfu/100mL, while sample site 6B had a count of zero one day and a count of 2933 cfu/100mL the next day (Table 3). This total nearly doubles the average count at sample site 6A. Rain did not proceed any of the sample days.

According to the AAS, the EPA's recommended maximum limit for a single count of *E. coli* is less than 235 cfu/100mL for designated swimming in fresh water, and limited swimming for counts less than 576 cfu/100mL (AAS, 2009).

These levels of chemical, physical and bacterial factors can, in part, be traced back to daily fluctuations in discharge rates for each sampling area in site 6. Upstream of the pedestrian bridge the average discharge at sample site 6A on June 23 was found to be 21.09 cfs/100 mL (Figure 2), while at Sample site 6B, just below the pedestrian bridge where the sample site was an area commonly considered a pool, the discharge on the same day was calculated at 0 cfs/100 mL (Figure 2). It should be noted that the discharge measurements for both sample sites were taken the day after a heavy rainfall event.

Being a national recreation area and a site protected by the Forest Service, a wide array of trees were found at both sampling sites. Sample site A, being located farther upstream of the parking lot, and therefore farther from frequent human use, generally showed overall healthier trees with the main risk factors leading to failure being root exposure due to bank erosion along the stream. However, at sample site B, many large Water Oaks and other older growth trees ranked at a higher risk rating and exhibited an assortment of other major risk factors including, but not limited to, split trunks, climbing vines, root and trunk decay, and poor tree architecture on almost all trees documented.

The physical locations of the sampling sites in the watershed along with their characteristics are revealed in their test results. At site 6 there is an even distribution of riffles, runs, pools with a deep wide channel with steeply cut banks and a healthy riparian zone with a wide diversity of trees, and groundcover. The banks are completely free of riprap or any type of bank restoration or stabilization. This is unusual since the banks are heavily undercut and in many places are commonly found to be very unstable.

Sampling site 6A with shallow water and a dense tree canopy overhead has a higher water temperature than site 6B but a lower air temperature. The shallowness of the site makes it easy for the water to be warmed by the sun during the day but also makes it cool off more rapidly. The deeper pools and runs at sample site 6B are slower to warm and cool which makes for a more stable environment for the aquatic life and plants. This is a likely factor playing a role in why the *E. coli* counts were so much higher at B and why there were more fish even though the water was much murkier and had lower dissolved oxygen (DO) levels.

The DO counts at both sites were all found to be over the Georgia Adopt-A-Stream requirements for growth and activity, but sample site 6A proximity to riffles and susceptibility to thermal stress and shock made it a poor host for plant and aquatic life. This is more evident in the *E. coli* samples taken at both sites with sample site 6A having an average count of 1417 and 6B having 2933. This disparity is due in part to the difference in environment for the *E. coli* colonies since site 6A is a cooler, rapid flowing section while site 6B is slower and warmer making it a more hospitable host for *E. coli* colonies. The second explanation for this is the physical location of the site to the parking lot and the point source pollutants of the trash cans and the trails used by people walking their dogs contributing to higher levels of pollution and habitat destruction in these areas. These sources contribute to the change in percent impervious surface area from 17.25% in 2003 to 29.42% in 2011 which is a stream health ranking of 'impacted" if not mitigated (GA DNR 2000), with most of this being designated to road coverage and commercial use at 11.4% and 9.10% respectively.

CONCLUSION

The Long Island Creek watershed is situated in the Upper Chattahoochee watershed of metro Atlanta classifying it as an urban stream. Over the last ten years, since the last study was conducted, development in Sandy Springs and the area around Long Island Creek has significantly increased (Figures 5 - 10). The increase in impervious surface area has caused a majority of the impact on the creek. Looking at the results of the chemical and physical testing, there are major impacts through the high levels of *E. coli*, phosphates, nitrates, and physical pollution. One can only wonder as to how the levels may change as the city grows and expands in the next years. In each site the levels of *E. coli* were all found to be very high and in or above the range for infrequent swimming. These high levels of *E. coli* are a significant sign of major urban impairment to the stream.

The next step to be taken is to locate the sources of this pollution. Once located, measures can be taken to reduce or eliminate the pollution. Some of the ways that can be done is to reduce the impervious surfaces around the immediate area of the stream. That will decrease surface runoff into the stream. Another option would be to limit and monitor any pipes or dumping that could be releasing harmful chemicals into the stream. Bank erosion also needs to be prevented to protect the stream and the plant life around it. Many trees are being severely threatened and have a high risk of failure. In a few years, one could most likely see a lot of fallen, close to falling or dead trees because of sever undercutting taking place along the bank

It is vital to the Upper Chattahoochee watershed that serious measures be taken to improve the water quality in this system. By assessing the quality of Long Island Creek groups are able to determine the necessary steps to be taken to improve this tributary as well as the head stream, in this case the Chattahoochee River. According to the data collected, the Sandy Springs Watershed Alliance and the citizens of Sandy Springs have a lot of work to do to help improve the quality of Long Island Creek. Damage to the stream is extensive, but can be repaired as long as the residents of Sandy Springs work to prevent additional pollution being added to the stream as well as help with cleanup. Awareness is the easiest and most helpful way to improve the environment, and Georgia Adopt-A-Stream makes information about the local watersheds around Georgia readily available as well as provides training for chemical and physical testing on streams. Volunteer groups make it possible to increase the chances of saving the watershed and restoring it to safer and healthier conditions.

After research completion, it was found that there were several things that could be improved to get a better study of the stream. More chemical testing could have been to see if there were other chemical pollutants in the water. High levels of *E. coli* were found, so more in depth tests could have been performed to find the different sources of the *E. coli*. Fish inventory was only assessed at one of the sites. Future studies should take stocks at multiple locations to determine the biotic integrity of the entire stream. More stable incubators would allow for accurate data collection. The LANDSAT images had a lot of variability in the classes due to multiple creators of the maps. Better organization could have been decreased the variance.

From this research it is necessary to question what personal, societal, political, and environmental steps can be taken to decrease the impact of an urban setting on streams. Is it possible to have an urban stream that lies within the limits of what is considered a healthy stream? If so, what progressive steps can be taken to reduce point-source pollution and non-point source pollution from impervious surfaces? What changes can be made at each level of society

to improve the water quality? As population density among urban areas increases, it will require collaborative efforts of all societal members to clean up and maintain stream systems so that they may return to a more natural state.

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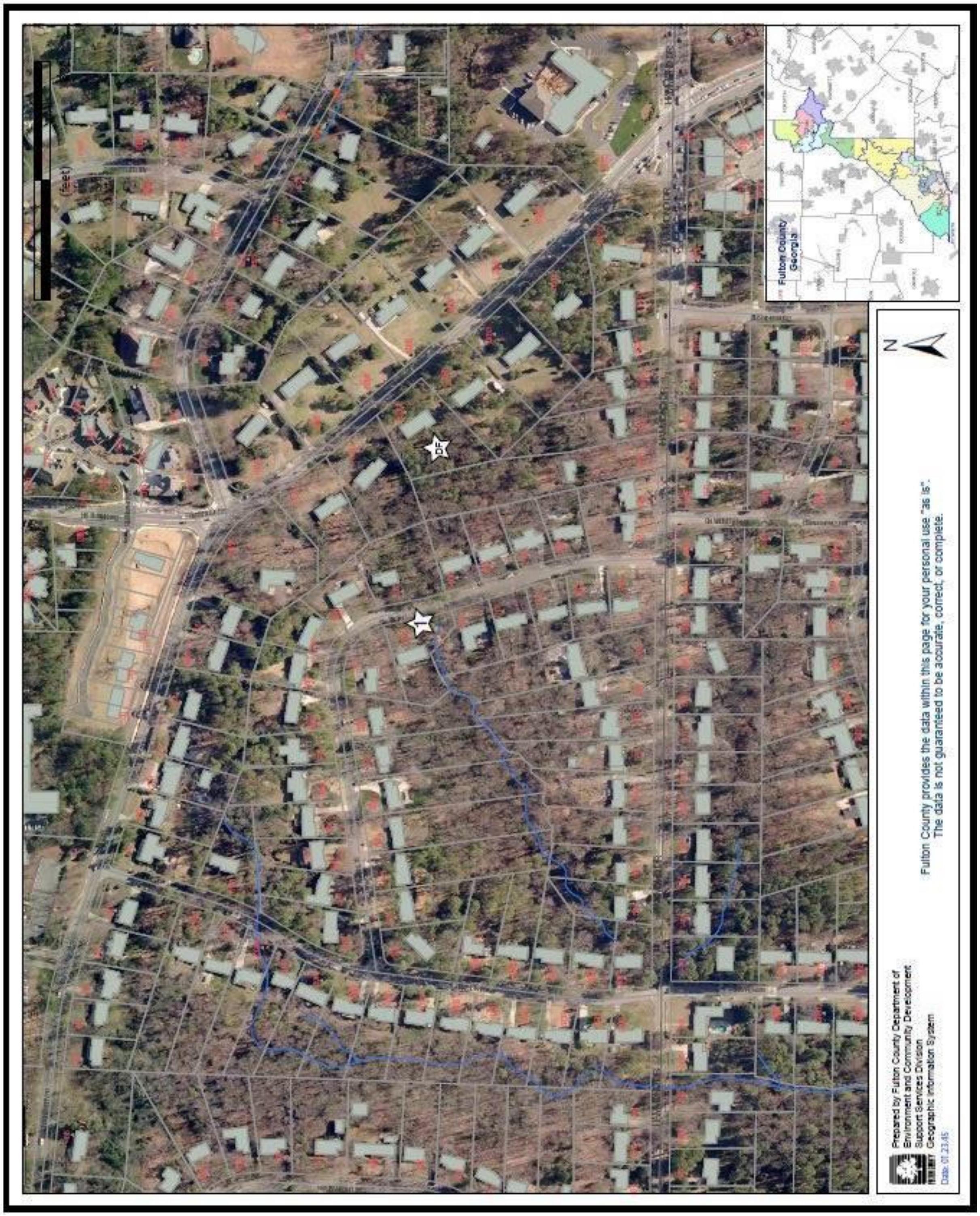
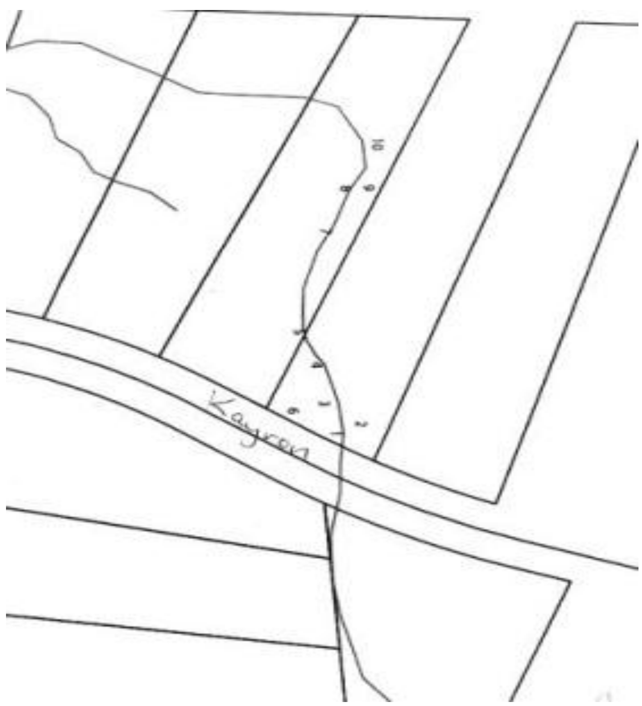
APPENDIX

Appendix A: Site 1



Group #	1
Date#	16, 20 June 2011
Time	Variable
Sample Sit	1A Kayron Dr.

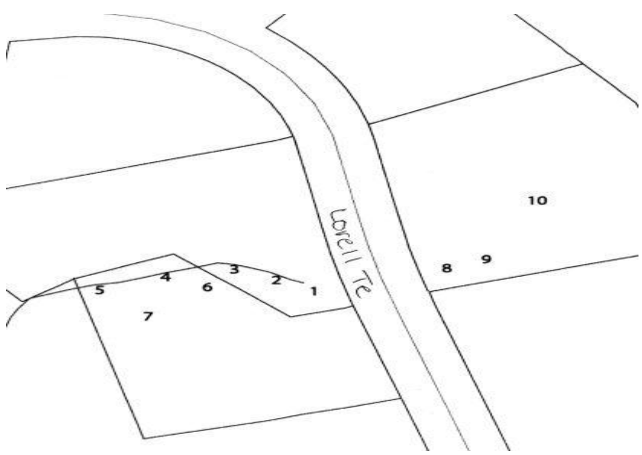
Tree #	Species (see species list for code	DBH (cm)	DBH (corrected)	Location	Defect code	Probabilty of Failur 1-4 points	Size of Defective part(1-3 points	Probabilty of Targe 1-3 points	Other Risk Facto 0-2 points	Description of Other risk facto	Risk rating (Sum G-J)
1	MaGr	31	9.87	KD 10		1	1	1	1	n/a	4
2	Quhe	126	40.11	KD 10	DEAD, CR	1	2	1	1	Dead branch not affecting inte	5
3	LiSt	219	69.71	KD 10		1	1	1	1	n/a	4
4	JuCi	55.5	17.67	KD 10		1	1	1	1	n/a	4
5	IlCa	223	70.98	KD 10	DEAD, CR	1	2	1	1	n/a	5
6	QuHe	178	56.66	KD 10		1	1	1	1	n/a	4
7	CeLa	45	14.32	KD 10		1	1	1	1	n/a	4
8	UlAm	37	11.78	KD 10		1	1	1	1	n/a	4
9	AcRu	115	36.61	KD 10	CR	2	2	1	1	Large split at main branch union	6
10	LiTu	32	10.19	KD 10		1	1	1	1	n/a	4



Site A Tree Locations

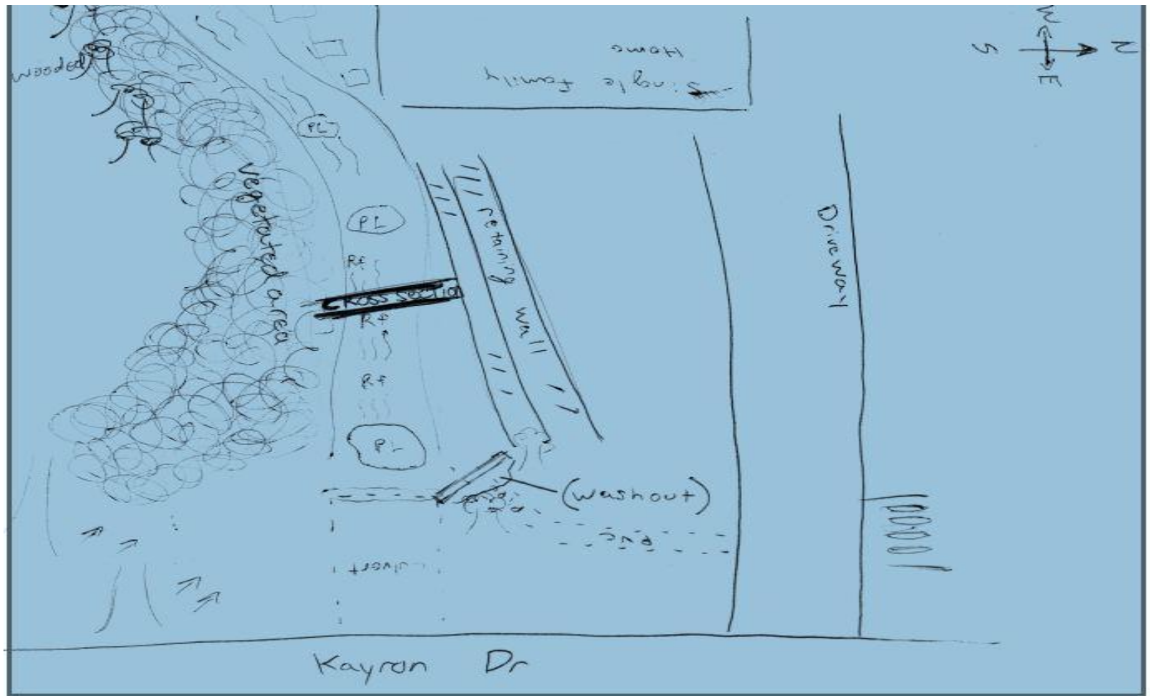
Figure A1: Community Index Site A

Group #	1										
Date#	16, 20 June 2011										
Time	Variable										
Sample Si	1A Kayron Dr.										
Tree #	Species	DBH	DBH	Location	Defect code	Probabilty of Failu	Size of Defective part	Probabilty of Targ	Other Risk Factc	Description of Other risk fac	Risk rating
	(see species list for cod	(cm)	(corrected)			1-4 points	1-3 points	1-3 points	0-2 points		(Sum G-J)
1	MaGr	31	9.87	KD 10		1	1	1	1	n/a	4
2	Quhe	126	40.11	KD 10	DEAD, CR	1	2	1	1	Dead branch not affecting inte	5
3	LiSt	219	69.71	KD 10		1	1	1	1	n/a	4
4	JuCi	55.5	17.67	KD 10		1	1	1	1	n/a	4
5	IlCa	223	70.98	KD 10	DEAD, CR	1	2	1	1	n/a	5
6	QuHe	178	56.66	KD 10		1	1	1	1	n/a	4
7	CeLa	45	14.32	KD 10		1	1	1	1	n/a	4
8	UlAm	37	11.78	KD 10		1	1	1	1	n/a	4
9	AcRu	115	36.61	KD 10	CR	2	2	1	1	Large split at main branch union	6
10	LiTu	32	10.19	KD 10		1	1	1	1	n/a	4

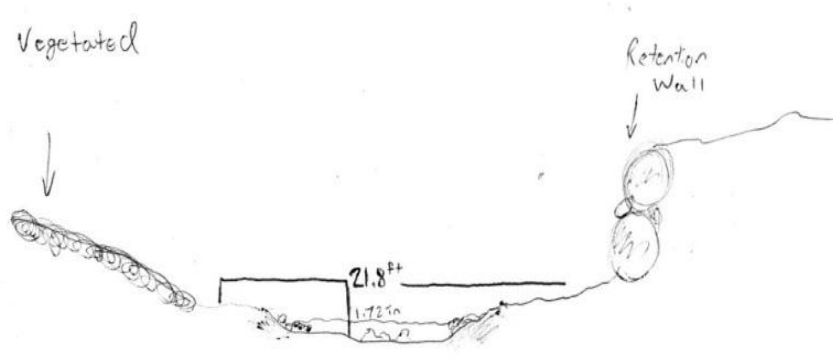


Site B
Tree
Locations

Figure A2: Community Index Site B

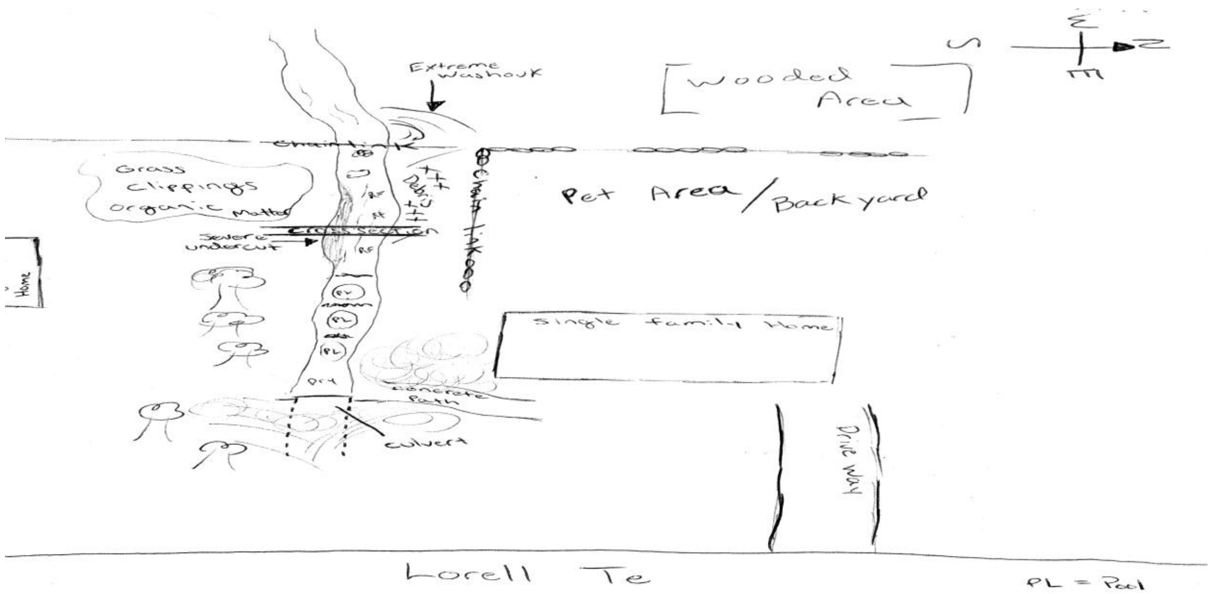


Site 1A Map

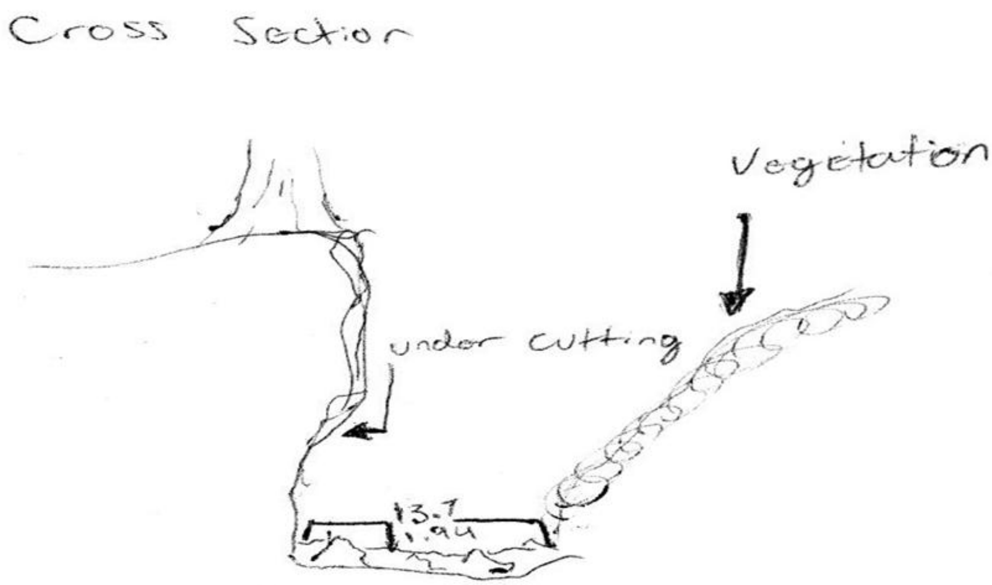


Site A Cross Section

Figure A3: Site Map and Cross Section



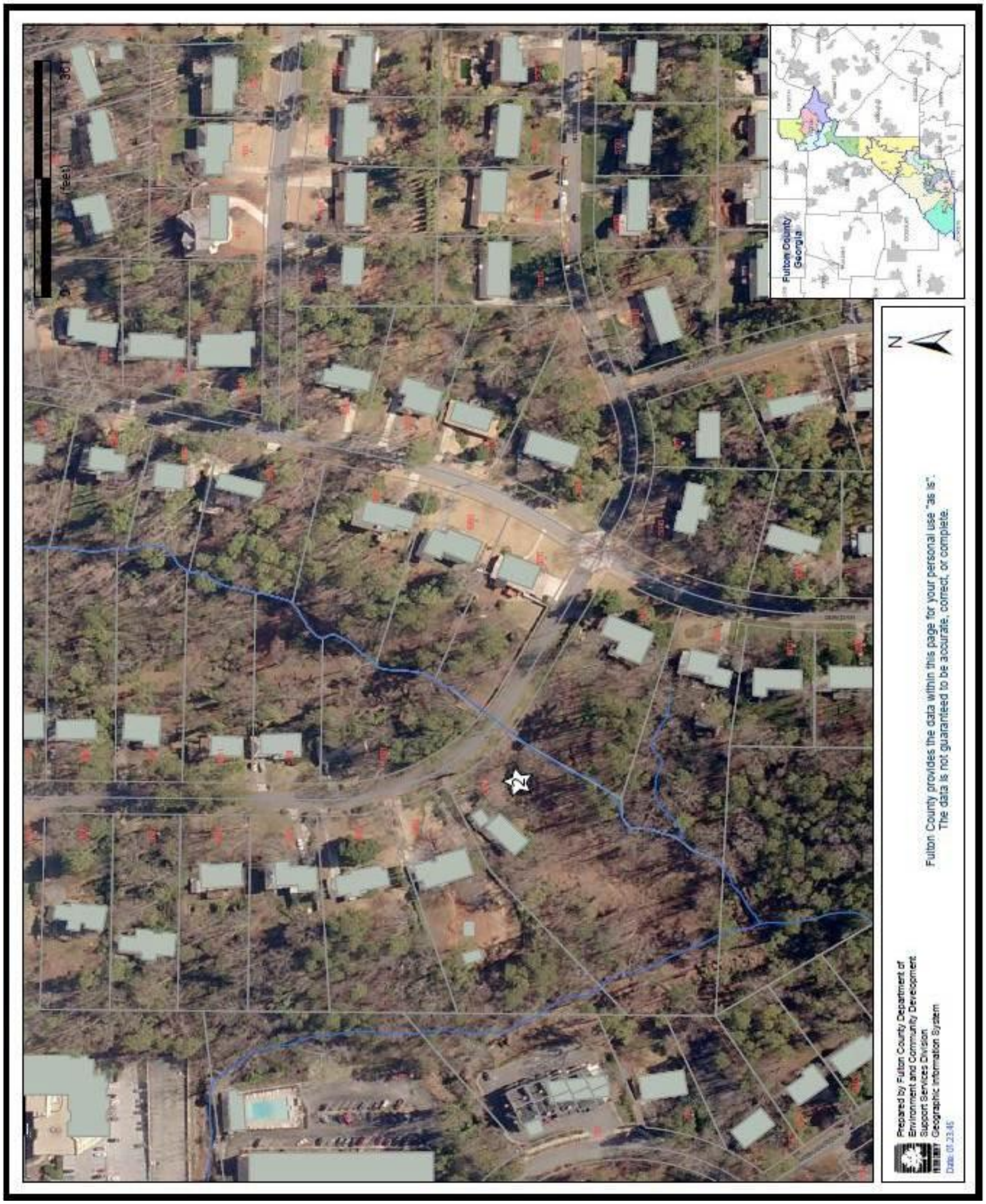
Site



Site 1B Cross Section

Figure A4: Site Map and Cross Section

Appendix B: Site 2

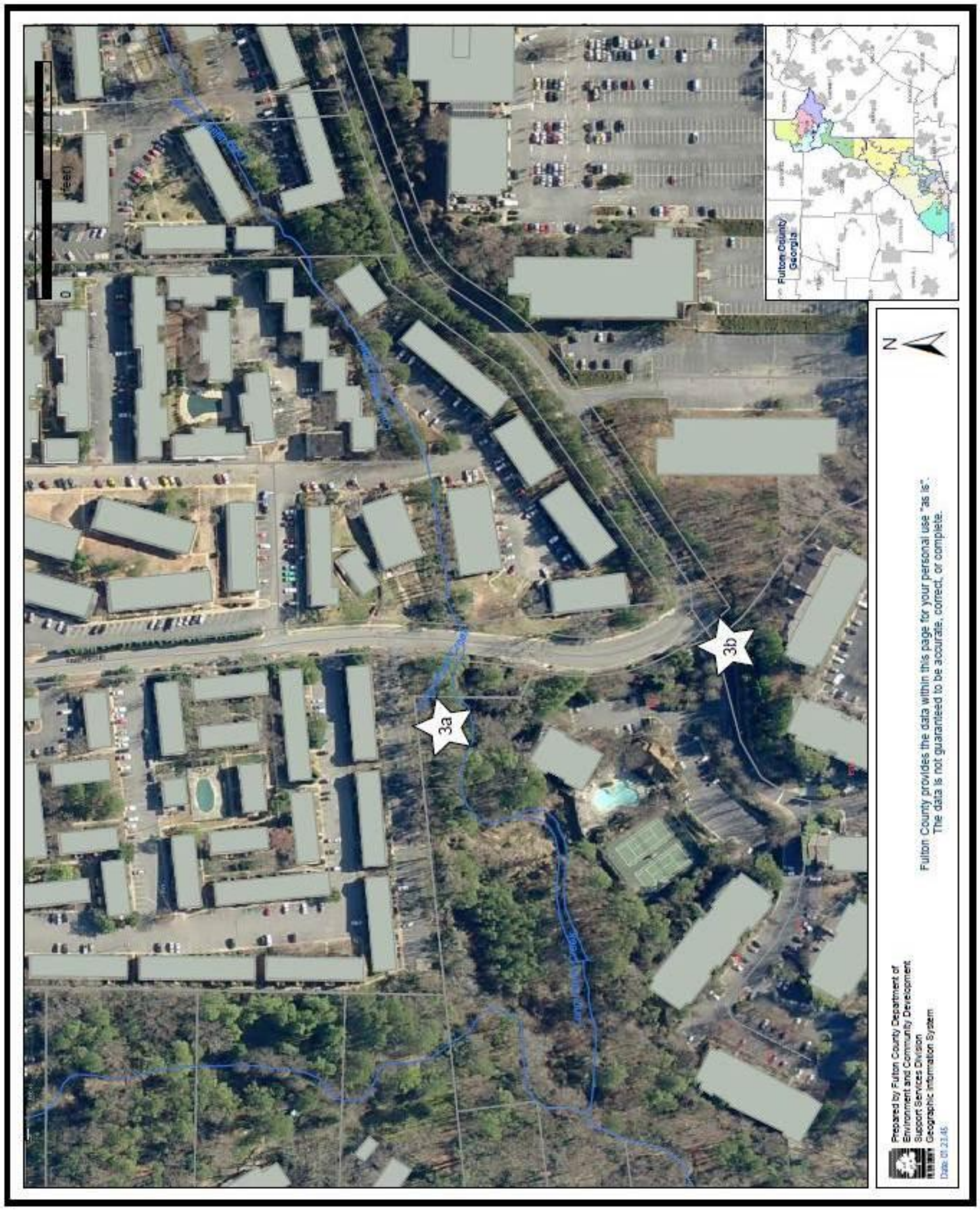


Community Index:

Tree #	Species	DBH	DBH	Location	Defect codes	Probabilty of Failure	Size of Defective part(s)	Probabilty of Target	Other Risk Factors	Description of Other risk factors	Risk rating
	(see species list for codes)	(cm)	(corrected)			1-4 points	1-3 points	1-3 points	0-2 points		(Sum G-J)
1	COSA	24	7.64	A		1		2			3
2	PITA	115	36.61	A	CR; PTA:LT; D	3.5	3	2	2	Ivey vines running vertically up 75%of the t	
3	FRAM	26	8.28	A	PTA:LT; RGC;	1.5	1	2			4.5
4	FRAM	25	7.96	A	R; RGC	2	2	2		Cut-bank erosion	6
5	LITU	89	28.33	A	RGC	1		2			3
6	LITU	102	32.47	A	PTA:LT	1		2			3
7	QURU	245	77.99	A		1		2			3
8	QURU	275	87.54	A		1		2			3
9	FRAM	24	7.64	A	PTA:LT; RGC;	2	1	2			5
10	PRSU	14	4.46	A		1		2			3

Tree #	Species	DBH	DBH	Location	Defect codes	Probabilty of Failure	Size of Defective part(s)	Probabilty of Target	Other Risk Factors	Description of Other risk factors	Risk rating
	(see species list for codes)	(cm)	(corrected)			1-4 points	1-3 points	1-3 points	0-2 points		(Sum G-J)
1	ACRU	135	42.97	B	PTA:LT; RGC;	3	2	2	1		8
2	QUVI	18	5.73	B	PTA:LT	2	1	2	0		5
3	BEAL	67	21.33	B		1		2	0		3
4	LIST	62	19.74	B	PO; PTA:LT	1.75		2	0		3.75
5	PRSU	82	26.10	B	PTA; DEAD	1.5	1	2	1	Heavy vine growth overloading branches ar	
6	LITU	224	71.30	B	PTA	1		2	0		3
7	LITU	290	92.31	B		1		2	0		3
8	FRAM	85	27.06	B	PTA:LT; RGC;	2.5	1	2	1	Heavy Kudzu growth vertically o	6.5
9	PITA	138	43.93	B	PTA:LT; DEAI	2.5	2	2	1	Heavy Kudzu growth vertically o	7.5
10	QURU	235	74.80	B		1		2	0		3

Appendix C: Site 3



Group #	1
Date	16-Jun-11
Time	12:05 PM
Sample Site	3A

Site 3A Community Index

Tree #	Species (see species list for codes)	DBH (cm)	DSH (corrected)	Location	Defect codes	Probability of Failure 1-4 points	Size of Defective part(s) 1-3 points	Probability of Target 1-3 points	Other Risk Factors 0-2 points	Description of Other risk factors	Risk rating (Item G-I)
1	ROPS	40.2	12.80		PTA, D, R	4	3	1	0	N/A	8
2	CABI	71	22.60		PTA, WBU, R	4	3	2	0	N/A	9
3	ALJU	30.5	9.71		PTA, WBU, R	2	2	1	0	N/A	5
4	CELA	50.3	16.01		PTA, WBU, R, PD	3	3	2	1	Impeded by bridge and fence	9
5	QUST	60	19.10		PTA, WBU, R, D	4	3	1	2	Over bridge	10
6	CACA	42	13.37		PTA, D,	2	2	2	0	N/A	6
7	MAGR	16	5.09		PTA, D, CR	4	3	1	0	N/A	8
8	ILOP	18	5.73		PTA, D	2	1	1	0	N/A	4
9	BENI	300	95.49		WBA, CA	2	3	2	1	Near electrical wires	8
10	ACSA	162	51.57		WBA, D	2	3	1	0	N/A	5

Table C1: Site 3A Community Index

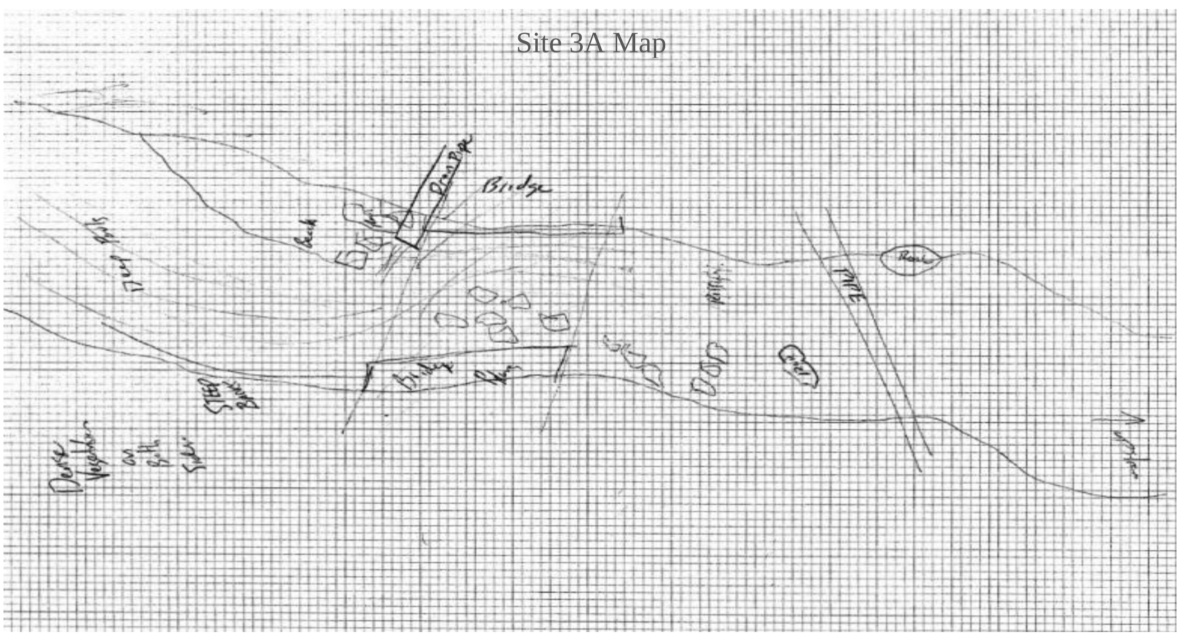


Figure C1: Site 3A Map

Site 3B Community Index

Group #	3
Date#	16-Jun-11
Time	9:40 AM
Sample Site	3B

Tree #	Species (see species list for codes)	DBH (cm)	DBH (corrected)	Location	Defect codes	Probabilty of Failure 1-4 points	Size of Defective part(s) 1-3 points	Probabilty of Target 1-3 points	Other Risk Factors 0-2 points	Description of Other risk factors	Risk rating (Sum G-J)
1	LITU	82	26.10		PTA	1	1	1	0	N/A	3
2	CACA	58	18.46		PTA, D	2	1	1	0	N/A	4
3	FRAM	96	30.56		PTA, CR, R	3	3	3	2	Potential to cause damage to apartment building and/or human injury	11
4	PLOC	169	53.79		PTA, WBU	2	2	1	0	N/A	5
5	PLOC	42	13.37		PTA	1	1	1	0	N/A	3
6	LITU	58	18.46		PTA, D, R	3	2	2	1	Potential to cause damage to apartment building and/or human injury	8
7	ILOP	61	19.42		PTA, WBU,	2	2	1	1	Potential to fall and block roadway	6
8	TSCA	31	9.87		WBU,	1	1	1	0	N/A	3
9	LIST	101	32.15		PTA, WBU, D	3	2	2	3	Near road and electrical boxes	10
10	PNEC	150	47.75		PTA, D	2	1	1	0	N/A	4

Table C2: Site 3B Community Index

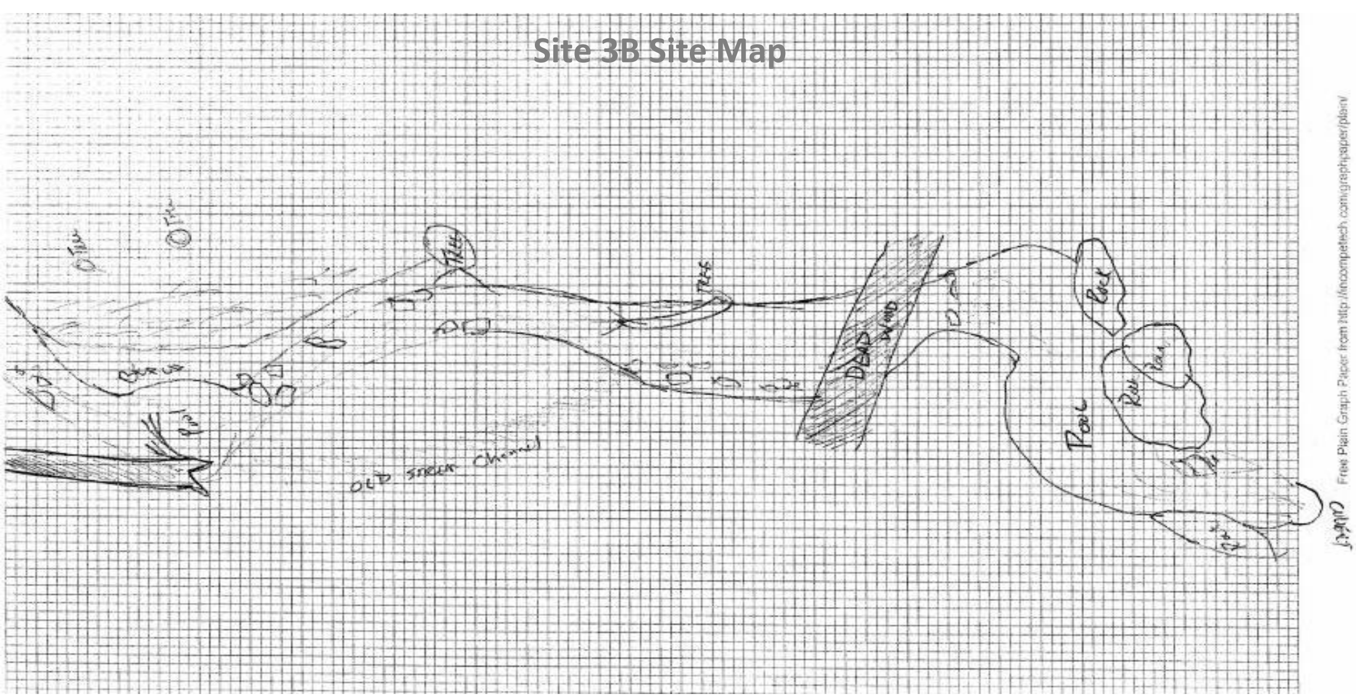


Figure C2: Site 3B Map

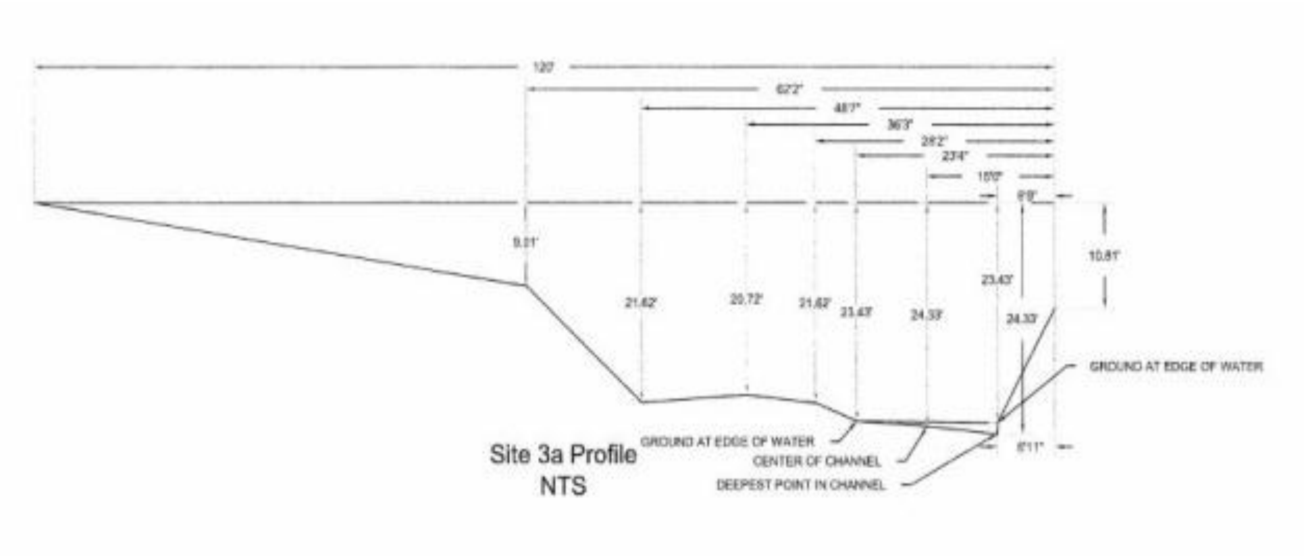
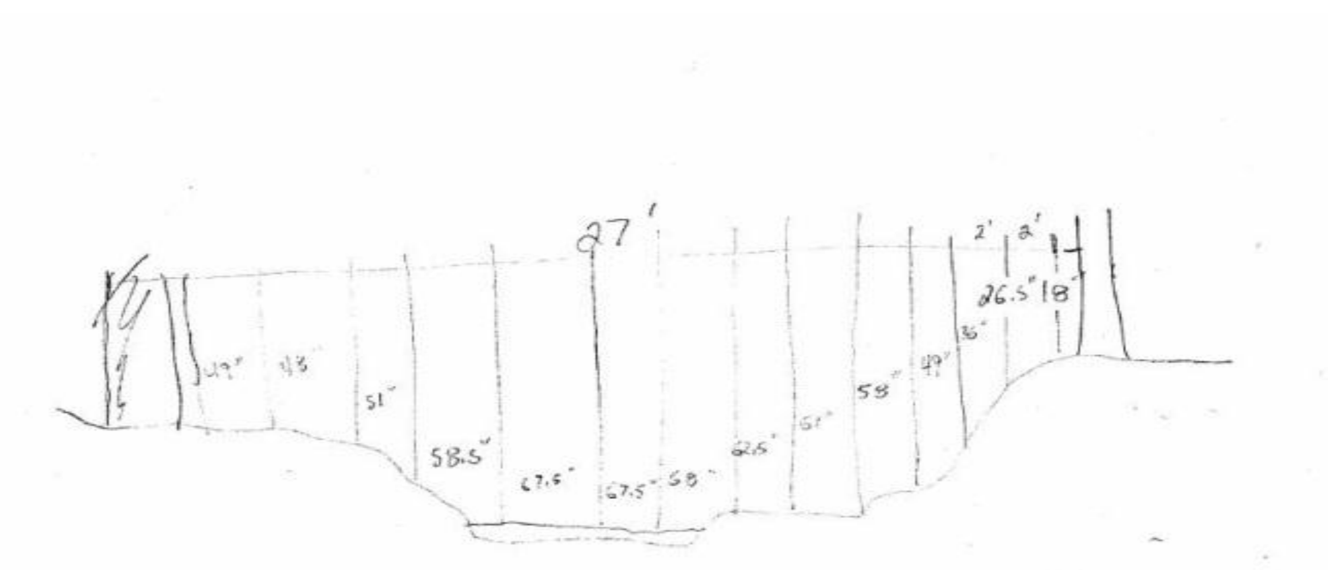


Figure C3: Site 3A Cross Section



Site 3B Profile

Figure C4: Site 3B Cross Section

Appendix D: Site 4

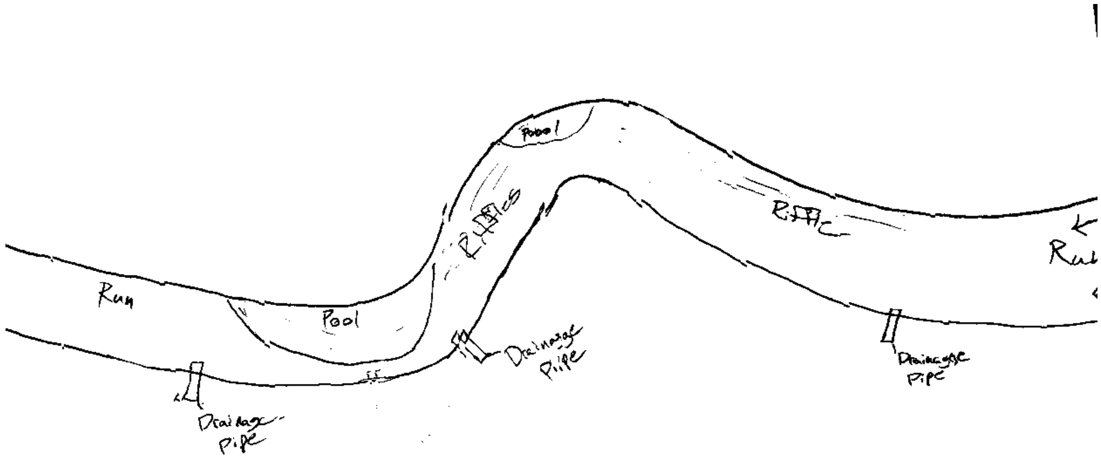


Figure D1: Site 4 Map

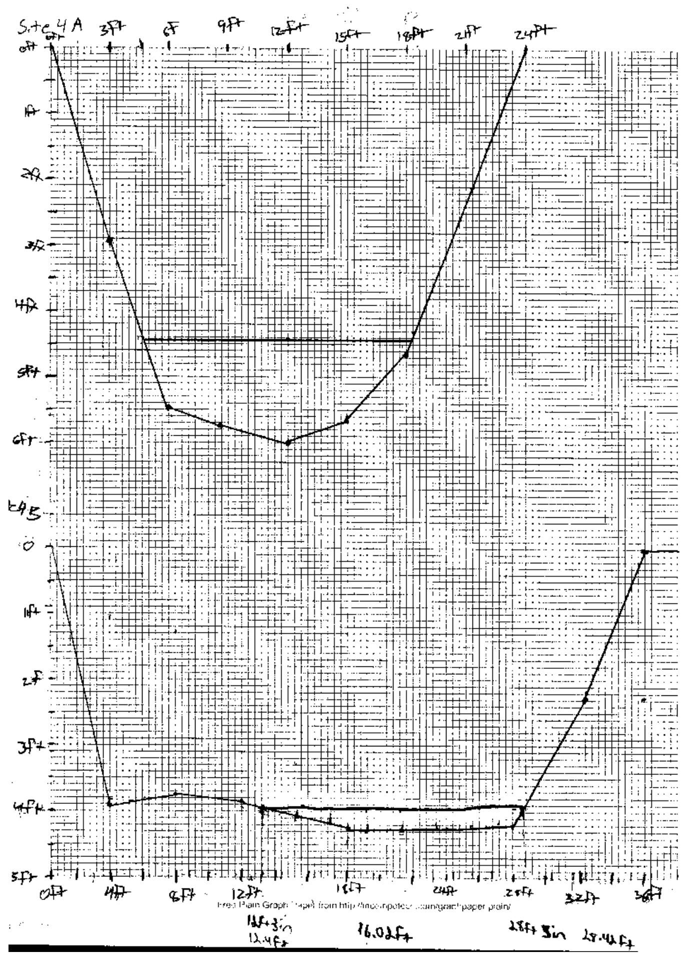


Figure D2: Site 4 Cross Section

Tree Inventory

Tree #	Species	DBH(cm)	Location	Defect Codes	Probability of Failure	Size of Defective Parts	Probability of Target	Other Risk Factors	Description of Other Risk Factors	Risk Rating
1	PLOC	3.66	16S 074254 375 4322	CR, Dead Roots	2	1	1	1	Erosion	5
2	PLOC	28.30	16S 0740248 375 4316	Roots, CA	2	2	1	1	Erosion	6
3	AIAL	10.50	16S 0740231 375 4297	CR, Dead Roots,Arch	2	2	1	1	Erosion	6
4	PLOC	47.71	16S 0740216 375 4315	Roots, Arch	1	1	1	2	Erosion	5
5	PLOC	97.82	16S 0740230 375 4312	Dead, CA, Arch	1	1	1	1	Erosion	4
6	BEOC	19.42	16S 0740216 375 4327	Dead, Arch, WBU	1	1	1	1	Erosion	4
7	BEOC	20.21	16S 0740241	Dead, WBU	3	2	1	2	Erosion, Vine	8
8	QUPH	30.33	16S 0740224 375 4307	Dead, Arch, WBU	1	2	1	1	Erosion	5
9	ACNE	27.50	16S 0740267 375 4309	CA, Roots, Arch	3	3	1	1	Erosion	8
10	LIST	16.97	16S 0740264 375 4317		1	1	1	1	Erosion	4
11	BEOC	14.36	16S 0737687 375 7373	WBU, Dead	1	1	1	1	Erosion, Vine	4
12	ACNE	19.61	16S 0737066 3757542	Arch, Dead	2	2	1	1	Erosion, Vine	6
13	PLOC	18.21	16S 0737943 375 7410	WBU	1	1	1	0		3
14	CACA	10.50	16S 0738149 375 7385	Arch, Dead, Roots	2	1	1	1	Erosion	5
15	LITU	29.92	16S 0738176 375 7354		1	1	1	1	Erosion	4
16	PLOC	30.72	16S 0738305 375 7327	Roots, Dead	2	2	1	2	Erosion	7
17	ACNE	19.19	16S 0737967 375 7503	Arch, CR, Dead	3	2	1	2	Erosion	8
18	ACNE	16.97	16S 0737967 375 7503	Arch	1	1	1	0	Erosion	3
19	PLOC	14.96	16S 0737942 375 7472	Arch, Roots, CA	3	3	1	3	Erosion	10
20	PLOC	21.84	16S 0737968 375 7442	Dead, Arch	1	1	1	0	Erosion	3

Figure D3: Site 4 Community Index

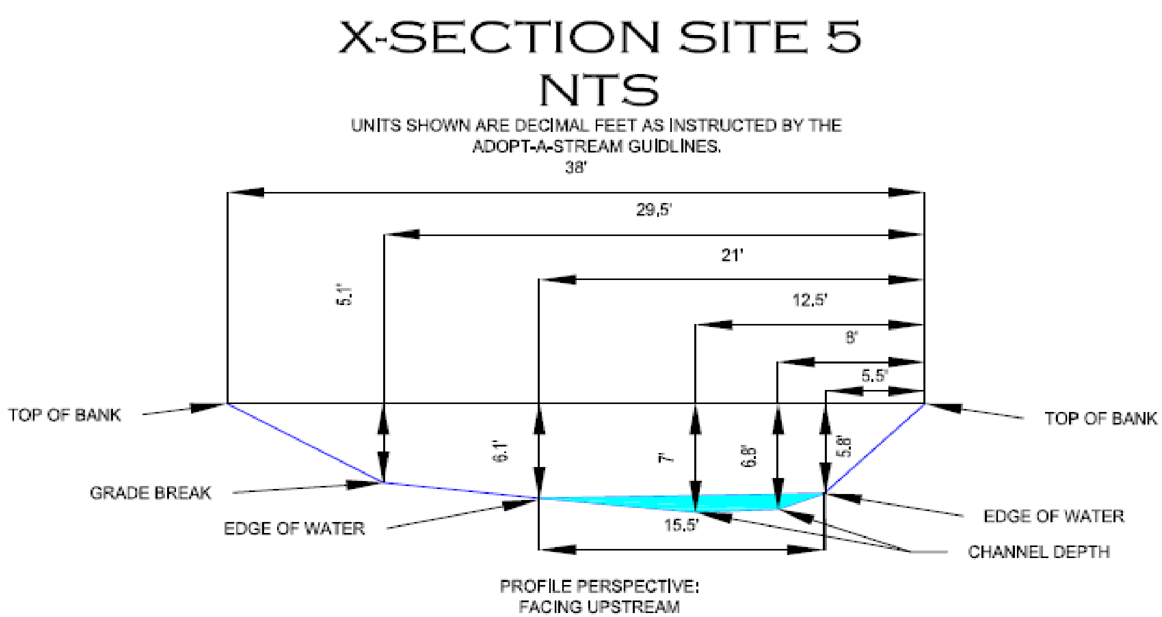
Appendix E: Site 5

USDA COMMUNITY TREE RISK EVALUATION FORM
Example Form *

Location: Site A Date: 16-June-2011 Inspector(s): Group 5

Tree #	Species	DBH	Location (Street Address)	Defect Code(s)	1 Probability of Failure 1-4 pts	2 Size of Defective Part(s) 1-3 pts	3 Probability of Target 1-3 pts	4 Other Risk Factors (Optional) 0-2 pts	Description of Other Risk Factors	Risk Rating (Sum of Columns 1-4) 3-12 pts	Corrective Action Code(s)	Action Completed Date	Action Completed Initials
1	ACNE	32cm	N3753053, E0738760	R	2	2	1			5			
2	QUFA	159cm	N3753055, E0738801		1	1	0			2			
3	COFL	10cm	N3753055, E0738801		1	1	0			2			
4	LIST	20cm	N3753097, E0738841	R	2	2	1			5			
5	QUNI	47cm	N3753111, E0738820	D	2	2	1			5			
6	POAL	74cm	N3753120, E0738824	D	2	2	1			5			
7	PRSE	45cm	N3753120, E0738824		1	1	0			2			
8	PNTA	58cm	N3753180, E0738792		1	1	0			2			
9	POAL	57cm	N3753203, E0738790		1	1	1			2			
10	PLOC	44cm	N3753116, E0738836	PTA:LT	2	2	1			5			

Community Index: Site 5A



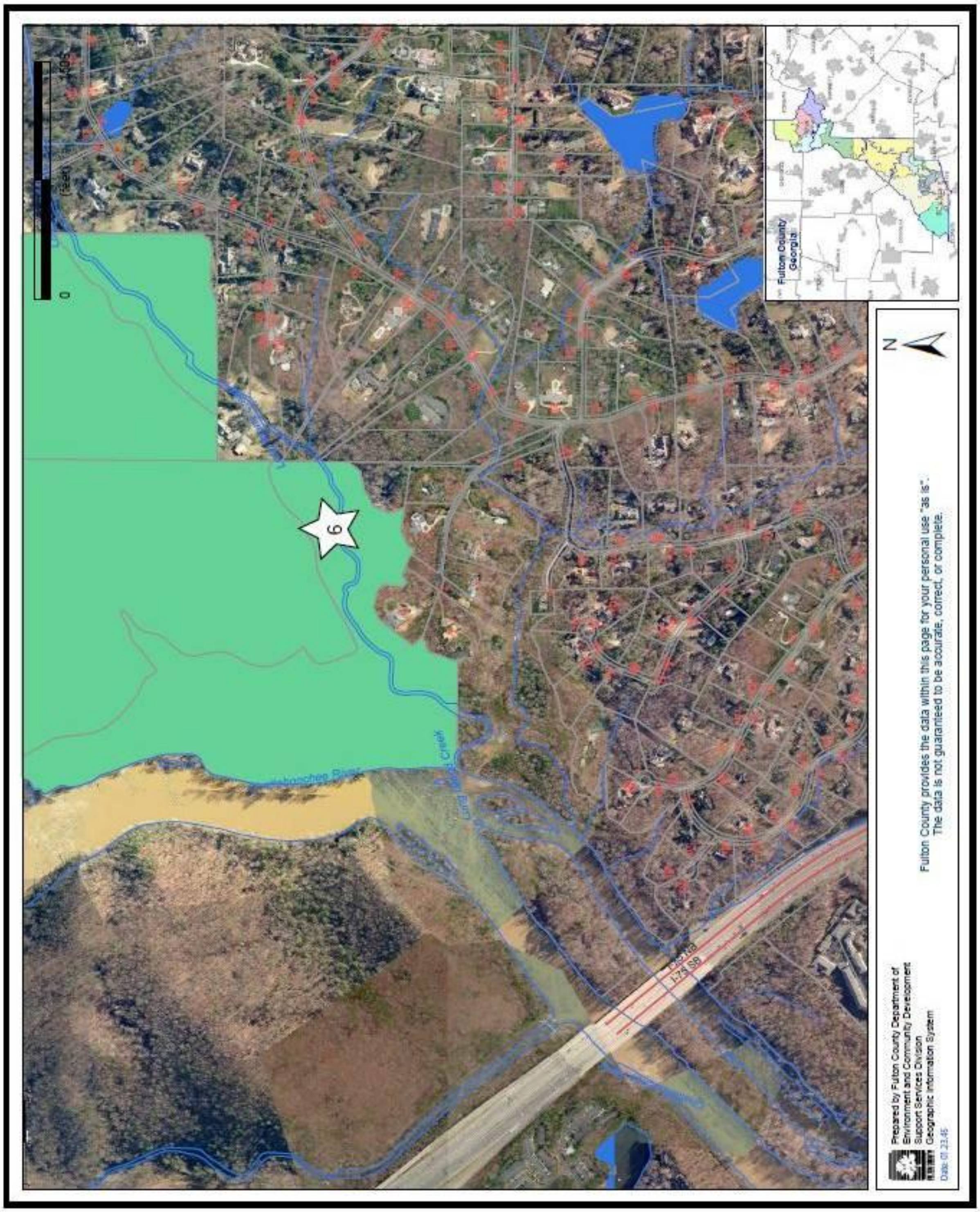
USDA COMMUNITY TREE RISK EVALUATION FORM
Example Form *

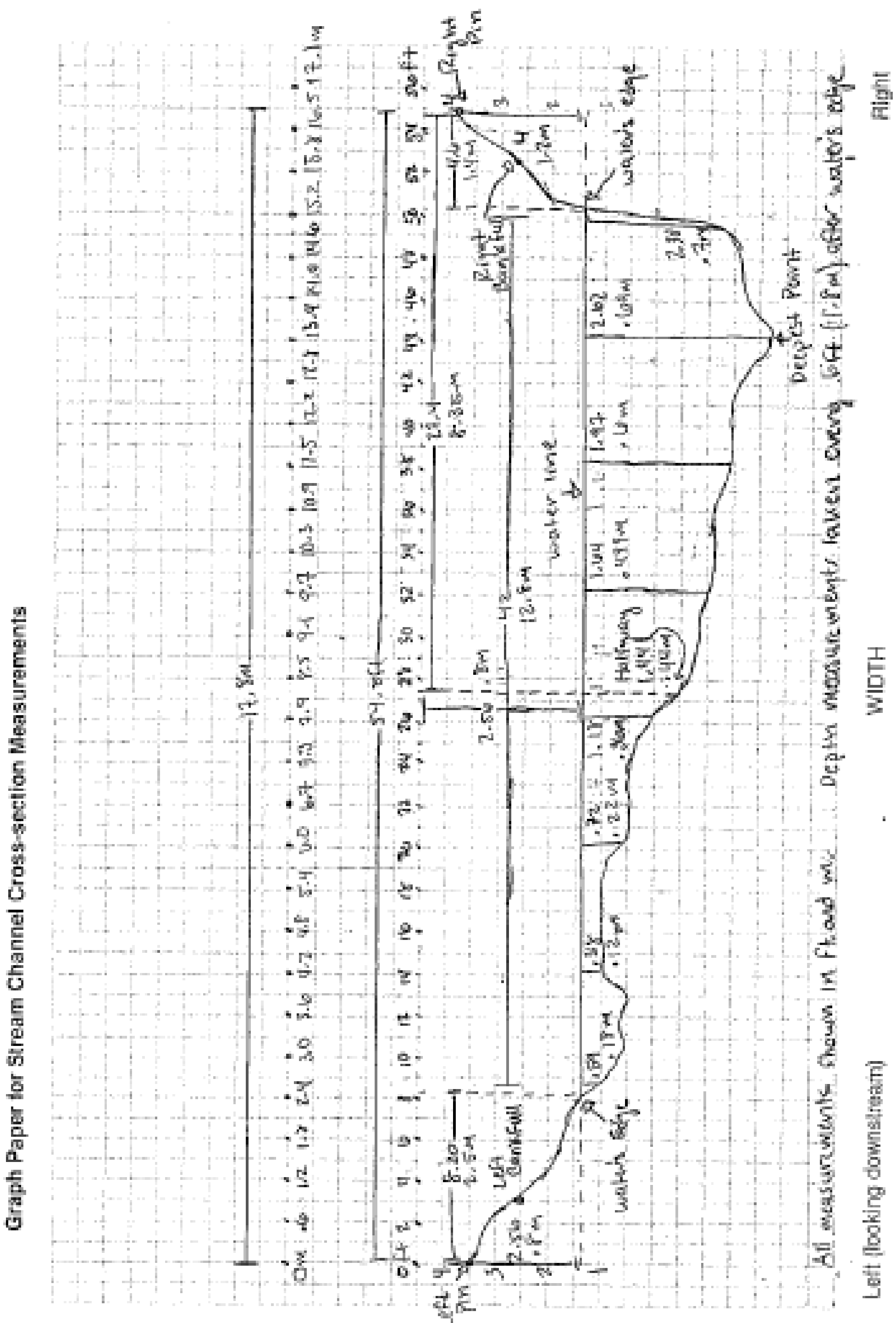
Location: Site B Date: 21-June-2011 Inspector(s): Group 5

Tree #	Species	DBH	Location (Street Address)	Defect Code(s)	1 Probability of Failure 1-4 pts	2 Size of Defective Part(s) 1-3 pts	3 Probability of Target 1-3 pts	4 Other Risk Factors (Optional) 0-2 pts	Description of Other Risk Factors	Risk Rating (Sum of Columns 1-4) 3-12 pts	Corrective Action Code(s)	Action Completed	
												Date	Initials
1	ACNE	62cm	N3753009, E073804		1	1	1			3			
2	CATO	50cm	N3753019, E0738693		1	1	1			3			
3	ACNE	35cm	N3753014, E0738720		1	1	1			3			
4	ACNE	24cm	N3753013, E0738732	R/RSB	2	2	1			5			
5	ACNE	29cm	N3753013, E0738732	R/RSB	2	2	1			5			
6	BENI	31cm	N3753024, E0738734	R/PTA,LT	2	2	1			5			
7	BENI	32cm	N3753034, E0738747	DEAD	3	3	2			8			
8	BENI	18cm	N3753039, E0738758	DEAD	3	3	2			8			
9	BENI	16cm	N3753039, E0738758	DEAD	3	3	2			8			
10	BENI	31cm	N3753039, E0738758	DEAD	3	3	2			8			

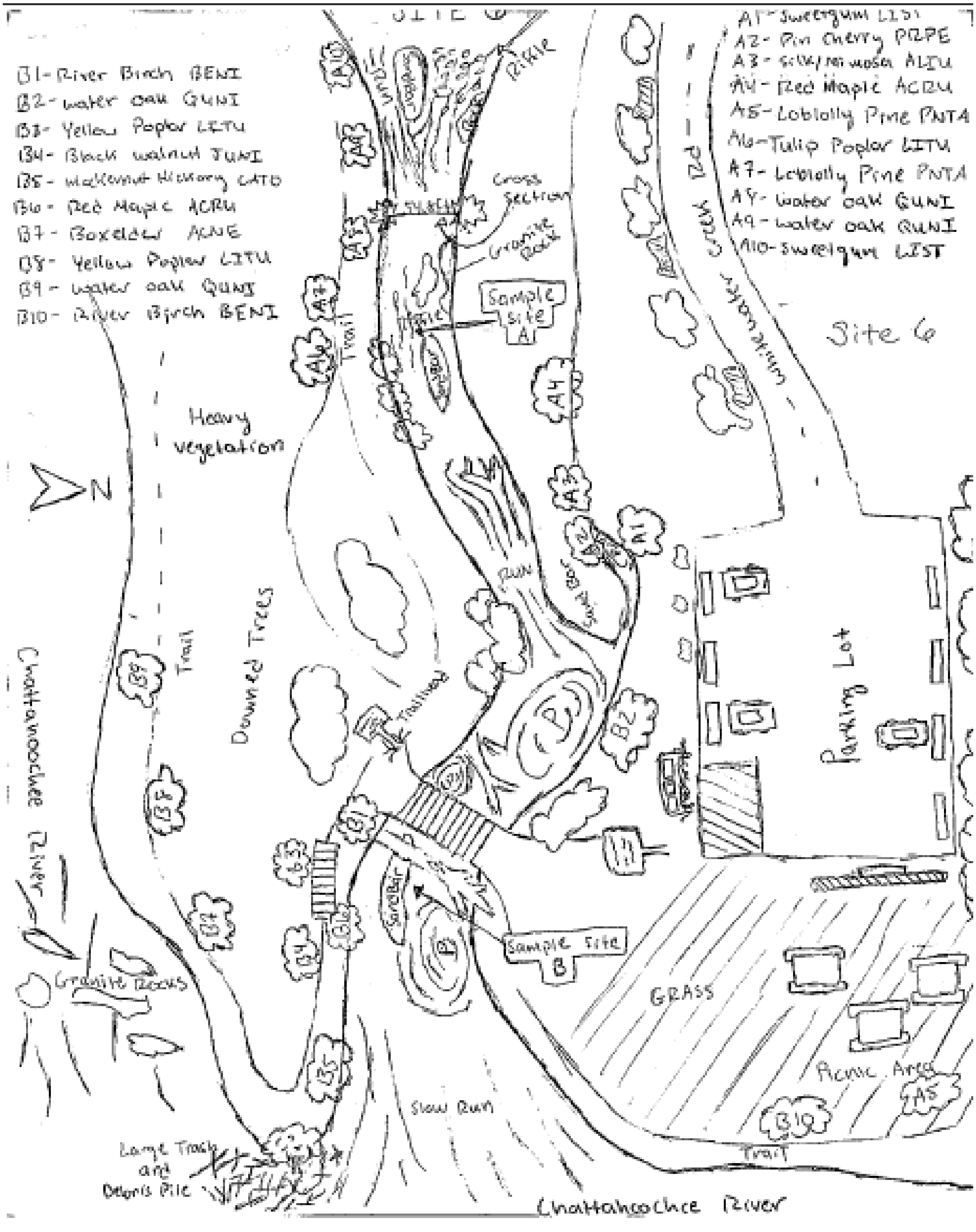
Community Index: Site 5B

Appendix F: Site 6





Cross Section: Site 6A



Site Map: 6A & 6B

Group # 6	
Date	16 Jun 2011
Time	11:30
Sample	
Site - A	

Tree #	Species (see species list for codes)	DBH (cm)	DBH (corrected)	Location Specified on map	Defect codes	Probability of Failure 1-4 points	Size of Defective part(s) 1-3 points	Probability of Target 1-3 points	Other Risk Factors 0-2 points	Description of Other risk factors	Risk rating (Sum 0-[illegible])
A 1	Sweetgum LIST	330cm / 105.1	105.1 0.00	Tree A1	CA CR, R	1	1	1	0		0
A 2	Pin Cherry PRPE	44cm / 14.01	14.01 0.00	Tree A2	PTA:LT CA	2	1	2	0	Bank erosion @ roots	5 0
A 3	Silk/Mimosa ALJU	29cm / 9.24	9.24 0.00	Tree A3	PTA:LT R RGC	2	1	2	0	"	5 0
A 4 ?	Red Maple ACRU	36cm	11.5 0.00	Tree A4	PTA:LT R RGC	2	1	2	0	"	5 0
not pine? A 5	Pine ? PNTA	103 cm	32.8 0.00	tree A5	DEAD CA WBU	1	2	2	0	Dead branches	5 0
A 6	Tulip (yellow) Poplar LITU	94	0.00	tree A6	DEAD, WBU	1	1	3	0		5 0
A 7	Loblolly Pine PNTA	224	0.00	tree A7	CR, DEAD	4	1	3	0		5 0
A 8	water oak QUNI	170	0.00	tree A8	CA, PTA:LT DEAD/R	1	1	2			4 0
A 9	water oak QUNI	390	0.00	tree A9	CR, R, LR	2	1	2		Exposed roots	5 0
A 10	Sweetgum LIST	187	0.00	tree A10	PTA:LT, CA, RGC, R	3	1	2		Bank Erosion	6 0

Community Index: Site 6A

Group # 6	
Date	16 Jun 2011
Time	11:30
Sample	
Site - B	By Bridge

River or Creek? I put River

Tree #	Species (see species list for codes)	DBH (cm)	DBH (corrected)	Location Specified on map	Defect codes	Probability of Failure 1-4 points	Size of Defective part(s) 1-3 points	Probability of Target 1-3 points	Other Risk Factors 0-2 points	Description of Other risk factors	Risk rating (Sum 0-[illegible])
B 1	Birch BENI	85	27.07 0.00	tree B1	R WBU PTA:LT	2	1	2	0	Bank erosion @ roots	5 0
B 2	Water Oak QUNI	275	87.58 0.00	tree B2	D; RGC; CA; PTA:LT DEAD	2	2	2	0	"	6 0
B 3	Yellow Poplar LITU	85	27.07 0.00	tree B3	CA; WBU DEAD PTA:LT	1	1	2	0	Crooked Trunk	4 0
B 4	Black Walnut JUNI	223	71.02 0.00	tree B4	CA WBU DEAD	1	2	2	0	Split trunk	5 0
B 5	Mockernut Hickory CATO	100	31.85 0.00	tree B5	D; CA; CR; R	2	3	2	0	Decay @ bottom	7 0
B 6	Red Maple ACRU	66	21.02 0.00	tree B6	PTA:LT CA	1	1	2	0	Poison Ivy Vine	4 0
B 7	Boxelder ACNE	70	0.00	PTA:LT RGC, DEAD,	PTA:LT, CA, CR, R	4	2	2	0		8 0
B 8	Yellow Poplar LITU	168	0.00	tree B8	PTA:LT DEAD	2	2	3	0	curved tree	7 0
B 9	water oak QUNI	232	0.00	PTA:LT Tree B9	CR, CA, PTA:LT	3	3	3	0	Climbing vines	9 0
B 10	River Birch BENI	127	0.00	tree B10	PTA:LT DEAD, WBU	2	2	2	0		6 0

Community Index: Site 6A